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The OIL WEEKLY

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WORLD OIL

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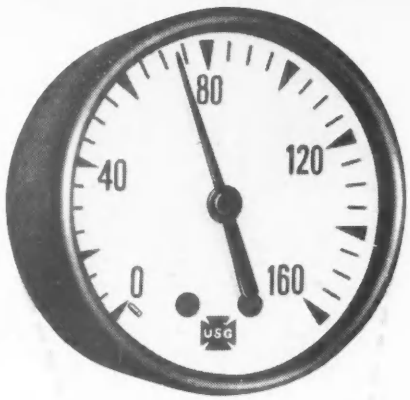

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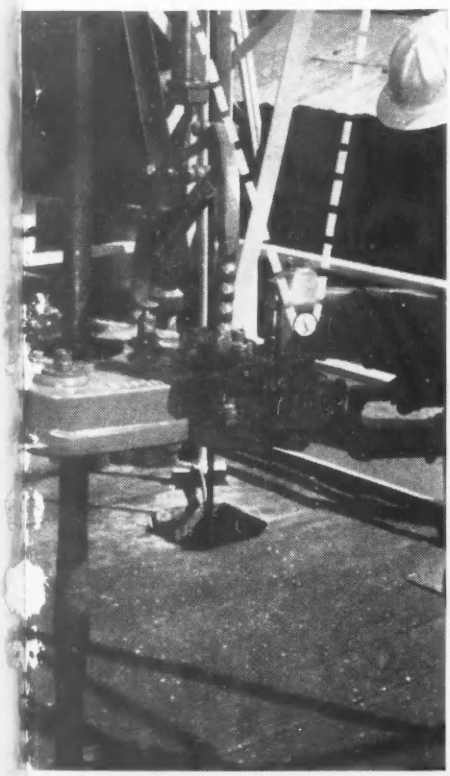

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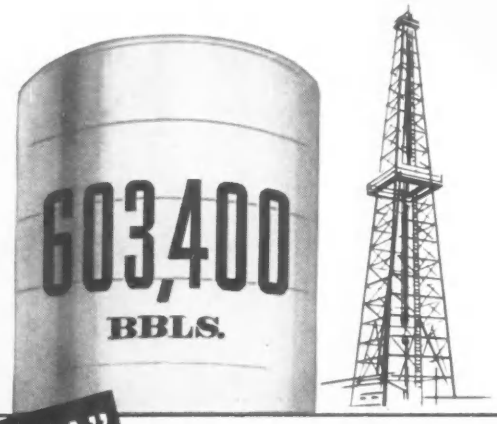
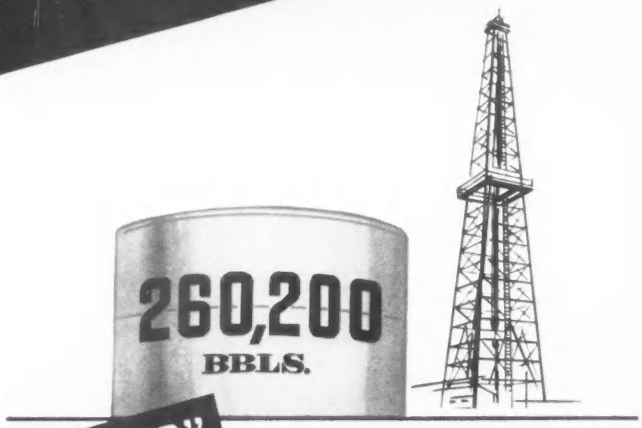


WELL "A" drilled with OIL BASE MUD

Date	Specific Productivity Index	Cumulative Production (bbls)
March 29, 1939	.02250	17,700
October 3, 1943	.00682	385,900
January 28, 1947	.00284	621,100

During the 94 months between the date of the first SPI (March 29, 1939) and the date of the last one (January 28, 1947), total production was 603,400 bbls., or a *monthly average of 6419 bbls.*



WELL "B" drilled with WATER BASE MUD

Date	Specific Productivity Index	Cumulative Production (bbls)
August 21, 1940	.00714	15,100
August 22, 1943	.00258	148,200
August 29, 1947	.00129	275,300

During the 84 months between the date of the first SPI (August 21, 1940) and the last one (August 29, 1947), total production was 260,200 bbls., or a *monthly average of 3,098 bbls.*, less than half!

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Md. ft. of sand	24,000	21,000

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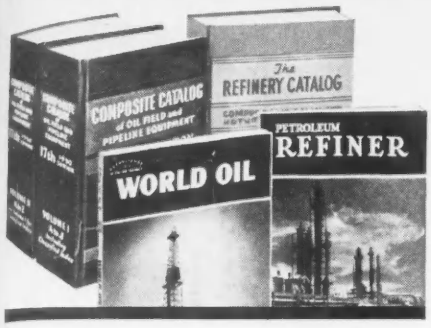

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WORLD OIL and The COMPOSITE CATALOG for the drilling-producing-pipe line industry

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Published every month except semi-monthly in February and July. Single copies 50 cents (except special issues). Subscription price: domestic and foreign, $2 a year; 2 years, $3; 3 years, $4. Advertising rates on application.

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Indexed by Industrial Arts Index and Engineering Index

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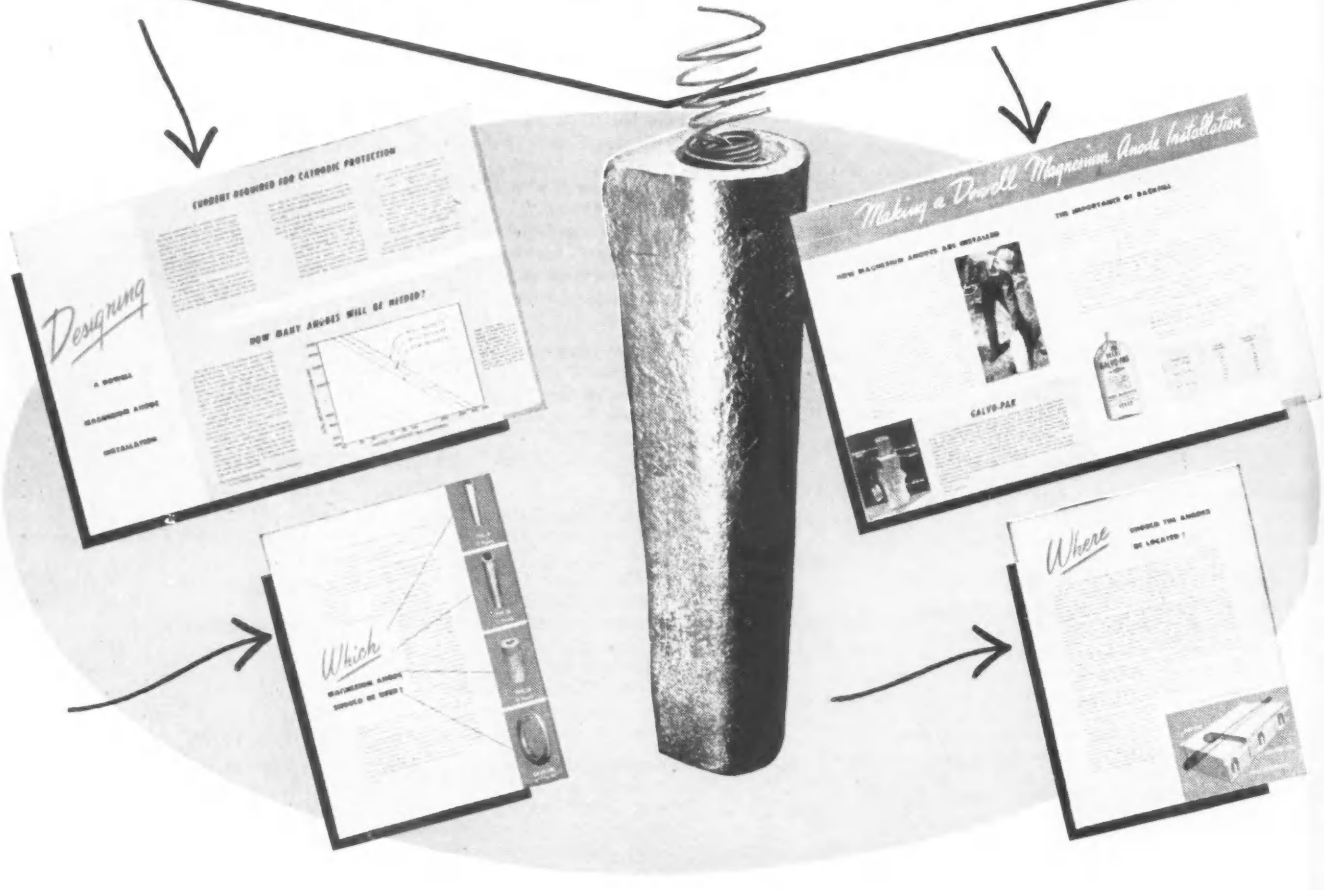

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Oh Lord, I Am Thankful

Oh Lord, I am thankful.

I am thankful that I live in a land where I can express my thanks to Thee, instead of being forced to go through the sham of thanking a dictator or a bureau for that which I have received.

I am thankful that my endeavors are selected by me, directed by me, and that I still have a substantial measure of control over part of the rewards for my own work.

I am thankful that, if my instincts are to share with my fellow men either of my time or my substance, I may, to a great extent, choose the less fortunate with whom I share.

I thank Thee, Oh Lord, for the right to speak and write as I will because if such right were taken from me, I would be little better than the dumb beasts of the field.

I thank Thee that, though ill feeling and even hatred seem to grow in our own country, still there lies between me and those with whom I daily come in contact a feeling of kindliness, and I pray Thee, Oh Lord, that such feeling of kindliness never be taken from our land.

I thank Thee that my right to worship is unrestrained. This, though I am too little a person of church form and creed, I know and appreciate, is a priceless heritage bequeathed by our forefathers, and I know that, though rivers of blood have flowed to help guarantee this right, there are today countries on our earth where Thy worship, in any form, may be undertaken only at risk of liberty or life.

I thank Thee that my posterity may be educated after the manner of my choice or the choice of their immediate parents without having them trained through organized propaganda to disregard the things which, since I have reached the age of accountability, I have known to be good.

I thank Thee that I may go from place to place, freely, in the pursuit of my work, or my happiness, with no ban imposed upon me because my travels do not fit into the pattern of a planned state or a dictator's whim.

I thank Thee that in our land even yet, in the face of all onslaughts, honor and integrity are highly regarded, that conscience has not been stilled altogether in high places but that the germ of decency is a germ within the hearts of most of those who live within our boundaries. I pray that this germ may grow.

I thank Thee, Oh Lord, for this generation of young men—both in our country and in the countries of our late allies—for without their sacrifices these thanks which I give to Thee this day might well be changed to a cry for help.

Oh Lord, there are **so many** things for which I am thankful!

But let me close my thanks with this prayer:

Oh Lord, give me the wisdom always to see and know the right. Give me the courage to say the things I know to be right, regardless of the effect upon me, and make me appreciative of the things which, when all is said and done, are best for all.

Ray L. Dudley

REPORT FROM
THE OBSERVATORY

Industry Can Improve Position

By RAY L. DUDLEY, Publisher, and WARREN L. BAKER, Editor
WORLD OIL'S summary of the oil situation at the close of December

AN EXCELLENT OPPORTUNITY to improve materially its economic position exists for the petroleum industry during the next 30 days. If operations are held to proper limits, stocks of crude and principal products can be brought nearer to year-ago levels. This would put the industry on a stable base from which it could advance at reasonable rates in succeeding months. Whether or not the industry succeeds in realizing the possibilities open to it depends upon the volume of refinery operations.

• • •

REFINERY OPERATIONS are the key to the situation, and January is the critical period because so little time remains thereafter for the industry to correct previous errors before winter is over.

With additional curtailment of production already programmed for January, the basis has been established for reducing crude stocks during the month to a point below that of a year ago. Of greater significance is the possibility of achieving a substantial improvement in refined product inventories. If refiners limit January crude runs to stills to near early December levels, fuel oil stocks should decline by sizeable amounts and at the same time the seasonal growth in gasoline inventories can be held considerably under the increases which occurred in January last year. By the end of January, reasonable refinery operations should drop distillate fuel stocks to year ago volumes, reduce residual fuel inventories well under those of a year ago, and also bring gasoline stocks somewhat closer to year ago storage.

On the other hand, any sizeable gain in refinery runs during January would have a disastrous effect. While crude stocks would be reduced more sharply, refined product inventories would increase by excessive amounts. This is especially true of gasoline, which would become particularly troublesome in view of the already high level of these stocks. Gasoline markets already are soft, and it would take little to start them tumbling. A cut in the price of crude certainly would follow any major decline in gasoline prices.

• • •

THIS OPPORTUNITY to bring inventories more closely into line with those of a year ago, and thus avoid much future trouble, is the result of a turn for the better in petroleum's economic position during December.

Increased demand caused by colder weather, coupled with reduced production and reasonable refinery operating rates, created favorable trends in December. Crude and fuel oil stocks were decreasing, bringing them close to levels in existence a year ago. Gasoline inventories were experiencing somewhat seasonable enlargement, but because the rate of growth was less than that of last year, they also became more closely aligned with year ago stocks.

After rising during November, crude stocks again were being reduced during December and appeared likely to drop below year ago levels before New Year's Day.

With colder weather existing, distillate fuel oil stocks had dropped to 82½ million barrels by December 17 compared with a peak of 92⅔ million barrels November 19. Whereas the stocks November 19 had been 13 million barrels above 1948 levels, they were only 6 million higher December 17. The situation was even more encouraging than indicated by the foregoing national figures. Distillate fuel inventories outside of California on December 17 were only 1½ million barrels above 1948 levels, although they had been 8¼ million barrels greater as recently as November 19.

• • •

RESIDUAL FUEL STOCKS also were declining in December. On December 17 they stood at 62¾ million barrels, which was 1⅔ million less than in 1948. A month previously these stocks had been 5¾ million greater than a year ago. Significantly, residual stocks outside of California on December 17 were 13⅔ million barrels under last year's volume.

Gasoline stocks on December 17 were 10¼ million barrels greater than at the corresponding period of 1948, but had been 13½ million above 1948 levels on October 1. This was after increasing from a low of 103⅓ million barrels on November 19 to 108½ million barrels on December 17. During the same four weeks of 1948, gasoline stocks rose 7 million barrels against the 5 million barrel gain in 1949.

The gasoline stock situation points out the urgency of holding crude runs to refinery stills to reasonable limits, and the additional advantage that would occur should gasoline yields be reduced.

The Changing Panorama

Railroads Important Oil Product Buyers

AMONG THE BETTER CUSTOMERS of the oil industry are the railroads, which will continue to consume large quantities of petroleum products, with requirements stimulated by the large-scale switch to use of diesel-powered locomotives. By 1970 the railroads will require 9 percent of the total production of the American oil industry, Standard Oil Company of Indiana has predicted.

While coal remains the biggest raw material purchase item of the railroads, petroleum purchases now exceed their outlay for forest products, heretofore one of the principal items on the railroad supply account.

Rise of railroads as buyers of petroleum products has been pointed out by the research committee of the Eastern Railroad Presidents Conference. The railroads' purchases of petroleum products reached a record high of about $220,458,000 in 1948, about 30 percent of their entire fuel bill, according to the study, which said this figure would be exceeded in 1949.

In 1941 diesel locomotives hauled only 0.2 percent of the freight traffic but by 1948 were handling 21.27 percent and now handle more than 32 percent. Diesel passenger service rose from 7.5 percent in 1941 to 40 percent through 1948. On dollar value basis, in 1948, only 13.8 percent of all fuel consumed by the railroads was diesel, but the diesel engines hauled one-fifth of freight gross ton-miles and more than one-third of the passenger train car-miles.

In March, 1949, the railroads installed 224 new locomotives, of which 216 were diesels and only 8 steam. On April 1, 1949, 97 percent of the 1322 locomotives on order were diesel.

Industry Should Have Interest in Highways

AS SUPPLIER of motor fuel and lubricants in vast quantities daily, the petroleum industry participates vitally in giving to the U. S. automotive transportation. This is a magic, fast growing system which in only a few decades has made the nation over, materially helping it to secure the world's highest standard of living.

A total of $30 billion was spent in the U. S. in 1948, according to the Brookings Institution, for automotive transportation, including outlays for vehicles, gasoline, lubricants, tires, batteries, repairs, and the numerous services contributing to motor vehicle operation.

This money was spent by virtually everybody, including motorist, salesman, motor fleet owner, bus rider, rural mail carrier, farmer. On the other hand, it was received by nearly everybody, directly or indirectly, for an expenditure as great as $30 billion ultimately spreads out and affects everyone.

This remarkable automotive transportation system still is growing and developing. It can further advance greatly the welfare of American business, including the petroleum industry, as well as the interests of the consumer and the public, if its growth is encouraged by sound policies. Contrariwise, the condition and growth of the system could be seriously impaired by unsound policies of taxation, regulation, and highway construction.

The petroleum industry needs to be greatly and actively concerned with the furtherance of the welfare of this $30 billion a year automotive transportation system, which it fuels and lubricates. In addition to its main job of providing petroleum products in ample volume at reasonable prices, the petroleum industry shares in the general responsibility of actively promoting adequate and safe highways and streets, efficiently built and maintained and paid for through equitable taxation.

Oil-Gas Leases Cover Tenth of U. S. Lands

U. S. OIL AND GAS industries paid out in 1948 to farmers, ranchers, and holders of royalty interests over $1.2 billion, including $400 million for oil and gas leases and bonus payments and $800 million royalties, an API survey showed. Exploration is being carried out in 37 states, and oil or gas production has been achieved in 28 states.

Leases cover 206,567,000 acres or 322,800 square miles of U. S. lands, representing 10.6 percent of the country's total land and inland water area of 3,022,387 square miles. In Texas, over 60 million acres of land are under lease, in Florida 26 million, California 17 million, Kansas 12 million, New Mexico 10 million, Oklahoma 7 million, Louisiana 6 million.

In each of 30 other states, including even New Jersey, Maryland, Delaware, Georgia, Virginia, Arizona, North Dakota, and Oregon, lease totals range from 34,000 to several million acres.

Depletion Allowance Under New Attack

AS INDIVIDUALS and through associations, oil and gas producers face the necessity of defending the 27½ percent depletion allowance and privilege of charging off intangible costs, long permitted for federal income tax purposes. It seems certain that President Truman and the Bureau of Internal Revenue will seek elimination or reduction of the allowance. Because of a prospective large government deficit next year, the administration is seeking sources of revenue which will not involve too many political repercussions.

The depletion allowance heretofore has stood up under previous attacks because of its soundness and reasonableness. It affords some compensation for the great financial hazards involved in prospecting for oil and gas and for the fact that after being found these natural resources are wasting assets.

It is predicted that the administration will base its case on the assertion that the special tax treatment actually enables an operator to bring oil and gas to the surface at the government's expense. While this may make a rather plausible case to uninformed sympathetic ears, it tells only half the story.

Soundness of the special tax treatment for oil and gas development is beyond question. The depletion allowance has become an essential element in the entire economic life of the oil and gas industries. Any change in this provision would have far reaching and disruptive results, particularly impairing and discouraging smaller companies and independent operators.

The percentage depletion allowance has been under attack before. In 1942 there was an attempt to eliminate the allowance entirely. But the soundness and justification of the tax law provisions made it possible for the industry then to ward off the attack.

Performance of the industry during and following the war, when ample oil and gas have been provided under difficult conditions, has demonstrated the wisdom of Congress in retaining the depletion allowance. It is just as sound in principle today as in 1942. Its continuance as a part of the tax law can be justified fully as effectively now. But the industry must meet the issue squarely and insist upon retention of the allowance.

Monthly News Analysis

INDUSTRY'S 1948 RECORDS APPROACHED . . . REFINING GROUP ORGANIZES CALIFORNIA SITUATION AIDED . . . ACTIVITY EXPANDS IN VIRGIN AREAS

Operations in 1949 Nearly Equal Records Set in 1948

Petroleum industry operations boomed along at near-record levels in 1949, although they fell short in some respects of equalling or surpassing the many all-time highs set in 1948, the API reported in its year-end review of the industry's activities.

Total demand for all oils, for domestic use and export, averaged 6,105,000 barrels daily, a decrease of only 0.4 percent from the 6,129,000 daily of 1948. Failure to exceed 1948 demand was due largely to unseasonably warm weather in both the first and fourth quarters of the year, which reduced normal heating oil consumption. A further decline in exports also was a factor.

Through benefit of an increase in consumption of motor fuel, which partially offset lagging exports and fuel oil use, the total domestic demand for all oils exceeded the 1948 record by a slight margin, setting a new high of 5,780,000 barrels daily, an increase of 0.3 percent over the 5,761,000 daily of 1948.

Exports of all oils averaged 325,000 barrels daily in 1949, compared with 368,000 daily in the previous year and 450,000 daily in 1947.

Although demand for petroleum and petroleum products was nearly as great in 1949 as in 1948, the industry in 1948 was producing and refining more crude than the markets then were absorbing, the surplus going to storage in volume averaging 291,000 barrels daily. In 1949, with demand lagging and failing to show customary growth, production of crude and products for storage was stopped, and for the year total stocks showed virtually no net change.

Supplying only current requirements and not adding to storage as in 1948, the industry necessarily cut back both refinery runs and crude oil production. Crude runs to stills averaged 5,310,000 barrels daily, down 5.1 percent from the runs of 5,595,000 daily in 1948.

In supplying the demand for oils, the industry as usual made use of natural gasoline and related products and substantial volumes of imported oils as well as domestic crude production, and since both natural gasoline production and imports were increased over 1948 rates, domestic crude output was curtailed relatively sharply. Production of natural gasoline and related products rose to 430,000 barrels daily in 1949 from 398,000 daily in 1948 and imports of all oils to 638,000 daily from 398,000. Domestic crude production was cut to 5,040,000 barrels daily in 1949 from 5,509,000 daily in 1948, a decrease of 469,000 barrels daily or 8.5 percent.

The further decrease in exports in 1949 was a continuance of the downward trend of the past five years. It reflected postwar restoration of refinery operations overseas and increased production in the Middle East, much of which now goes direct to Europe.

While U. S. crude output declined 469,000 barrels daily or 8.5 percent in 1949, crude production for the rest of the world rose to 4,123,000 barrels daily from 3,819,000 daily in 1948, an increase of 304,000 barrels or 8.0 percent. For the whole world, crude production of 9,164,000 barrels daily in 1949 was only 164,000 daily or 1.8 percent under the 9,328,000 daily of 1948.

Despite curtailment of operations in the U. S., the industry proceeded with expansion and modernization programs in 1949, having invested over $2 billion, as in each of the two preceding years. Refinery capacity was given a net increase of 73,000 barrels per day and rose to an all time high of 6,550,000. Well completions were off only slightly from the 1948 peak, and wildcatting again set a new record, indicating another large addition to proved reserves of oil and gas. Among the year's outstanding achievements in the industry was the setting of a new drilling depth record exceeding 20,500 feet, in a Wyoming wildcat. For petroleum research, the industry continues to invest more than $100 million annually.

Refiners Organize to Seek Improvement in Situation

Although the industry as a whole has remained in a generally favorable position, weak markets and price adjustments of the past year have caused some serious dislocations and maladjustments within the industry, and the refining division has been among the segments most adversely affected.

This fact was emphasized by the recent formation of the Independent Refiners Association of America by refiners of 25 states. Banding of these independents into a national organization, with headquarters in Houston, was precipitated by unfavorable conditions in the industry from the standpoint of independent refiners.

"Conditions in the industry which have led in recent months to closing of a number of independent refineries have created an emergency," stated Harry Leyendecker, vice president of Eastern States Petroleum Company, temporary chairman of the new association's executive committee. "The association will work by all lawful and legitimate means to prevent additional closings, and in cooperation with other units of the oil industry and with the understanding and help of the general public, to bring about conditions which will enable the independent refiners to survive."

For almost a year, independent refiners have been experiencing serious difficulties caused by lagging demand and unstable markets for petroleum products. Margins of profit have shrunk or vanished as prices of fuel oils have declined without being fully compensated by reductions in crude prices, although postings for heavier crudes have been sharply lowered. The situation has been aggravated by record-breaking imports of crude oil and residual fuel oil, spokesmen for independent refiners have contended.

It seems evident also that difficulties of independent refiners have been caused in part by technological developments as well as by market conditions, as much new and improved refining capacity has entered the scene to compete for available business.

Among the problems to be dealt with by the independent refiners through their new national association will be those which can be influenced by the government. "The IRAA will carry on an educational program within the oil industry and work with members of Congress and Congressional Committees to present independent refiners' viewpoint on legis-

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lation affecting the industry," stated Leyendecker. "It will also act as spokesman for independent refiners on local, state, and regional levels. Every other oil industry group, from producer and royalty owner to the large integrated companies, has an authoritative spokesman."

Formation of IRAA was sponsored by the Gulf Coast Refiners Association.

California Situation Helped By Seasonal Fuel Oil Demand

There has been continued improvement in the statistical position of California's oil industry, because of seasonal increases in demand for stove and heating oils and residual fuel oil and an accompanying reduction in previously excessive supply.

In a report issued December 15, the Oil Producers Agency of California, on the basis of weekly figures of the API and U. S. Bureau of Mines, estimated November demand at 1,014,000 barrels per day, with supply at 969,000 barrels daily, resulting in a withdrawal of 45,000 barrels per day from high inventories.

The report stressed, however, that the improvement was due entirely to seasonal factors, which accounted for peak demands for fuel oils. Added to the high seasonal demand were the current temporary fuel oil shipments to the East Coast, which during November were estimated at 62,000 barrels daily, or more than the total withdrawal from storage during the month.

The report also summarized final industry results for October, based on the U. S. Bureau of Mines report, "The Petroleum Situation in District 5." In that month, total demand for California oil was 1,003,000 barrels per day, with supply at 969,000 per day, resulting in a withdrawal of 34,000 daily from stocks. As in the estimates for November, October stock drafts were due to seasonal factors affecting heating and fuel oils and to shipments of the latter to the East Coast.

Canadian Discoveries Cause Search for Oil in Dakotas

One of the salutary effects to be felt by the American oil industry as a result of recent Canadian successes is the intense interest with which oil operators are seeking new fields in virgin areas such as the Dakotas. These northern regions have experienced sporadic exploration but never on such a widespread scale as current reports indicate. There are a number of important basins located in the North Central states, but few major operators have been attracted to the areas. The play, heretofore, has centered in the Rocky Mountain provinces. The successes achieved in Western Canada and the interest manifested in Manitoba and Saskatchewan now turns the spotlight on what may prove to be the locale for substantial new oil and gas reserves.

Mid-Continent oil operators report a heavy lease play in North Dakota, with interest centering on the region east of the Williston Basin, playing both structural conditions and stratigraphic traps against the Uplift. Union Oil Company of California and The California Company are pacing the play, which centers in Cavalier, Ramsey, Nelson and Western Walsh counties. Out of an estimated 1½ million acres under lease in that area, Union Oil is reported to hold about 200,000 acres. Most leases have been taken for ten years, with bonus payments ranging from 10 cents to 50 cents an acre with 10 cents an acre annual rental.

Local businessmen are also reported supporting the play by backing at least two wildcat tests. The locally financed Red River Development and Oil Company is drilling about four miles west of Grand Forks. Total depth when rotary was torn down and cable tools substituted was 1685 feet, and this is the deepest well, geologically, in the state. Leasing and geophysical crews are working out of Devils Lake, Lakota and Grand Forks, and it is expected that the coming spring will see several exploratory wells in the area.

ECA Disapproves Projects Threatening Unfair Trade

Economic Cooperation Administration has declared its intention to refuse to finance petroleum expansion projects of foreign countries where the output of such expanded facilities can be sold only by resorting to discriminatory trade practices. Dr. Oscar Bransky, chief of ECA's petroleum branch, recently disclosed this policy to Congress in warning that if European currency restrictions continue, the burden of oil surpluses would be borne largely by American companies operating abroad.

Bransky also revealed that ECA was in consultation with British government representatives in an effort to remove trade discrimination practices which are driving dollar oil from the world's markets. Industry observers have construed Bransky's statement as hinting that the British-American oil talks which have been under way in Washington the last two months may now turn on the readiness of British and Dutch oil interests to abondon such drastic anti-American practices as non-convertible currency regulations, bilateral trade pacts, and sterling preferential business policies and to abandon them before sterling oil captures the major global export markets at the expense of the American industry and the American taxpayer. However, Bransky warned, "the continuing dollar shortage probably will prevent the return to normal competitive conditions in the foreseeable future."

Bransky disclosed that ECA has refused to finance any part of the British oil expansion program as far as the purchase of petroleum equipment is concerned. He said:

"The Marshall Plan's petroleum equipment program comprises two parts: the refinery expansion, drilling and maintenance program in Europe itself, and overseas expansion programs of the companies owned by nationals of participating countries. The policy we adopted regarding financing of overseas expansion was that we would finance such expansion only if the resulting new output was mainly needed in Europe for recovery; but not if the output was intended for export to third areas. This policy was communicated to the British whose companies were mainly engaged in the overseas expansion program. Up to the present moment we have not financed any part of this program."

A significant change is taking place, said Bransky, "in the shift from dollar to non-dollar sources of supply of Europe's oil imports. It is estimated that Europe's crude oil imports will increase from about 20 million tons in fiscal 1949 to slightly more than 27 million tons in fiscal 1950, while imports of refined products will be reduced from 29.5 million tons to less than 27 million."

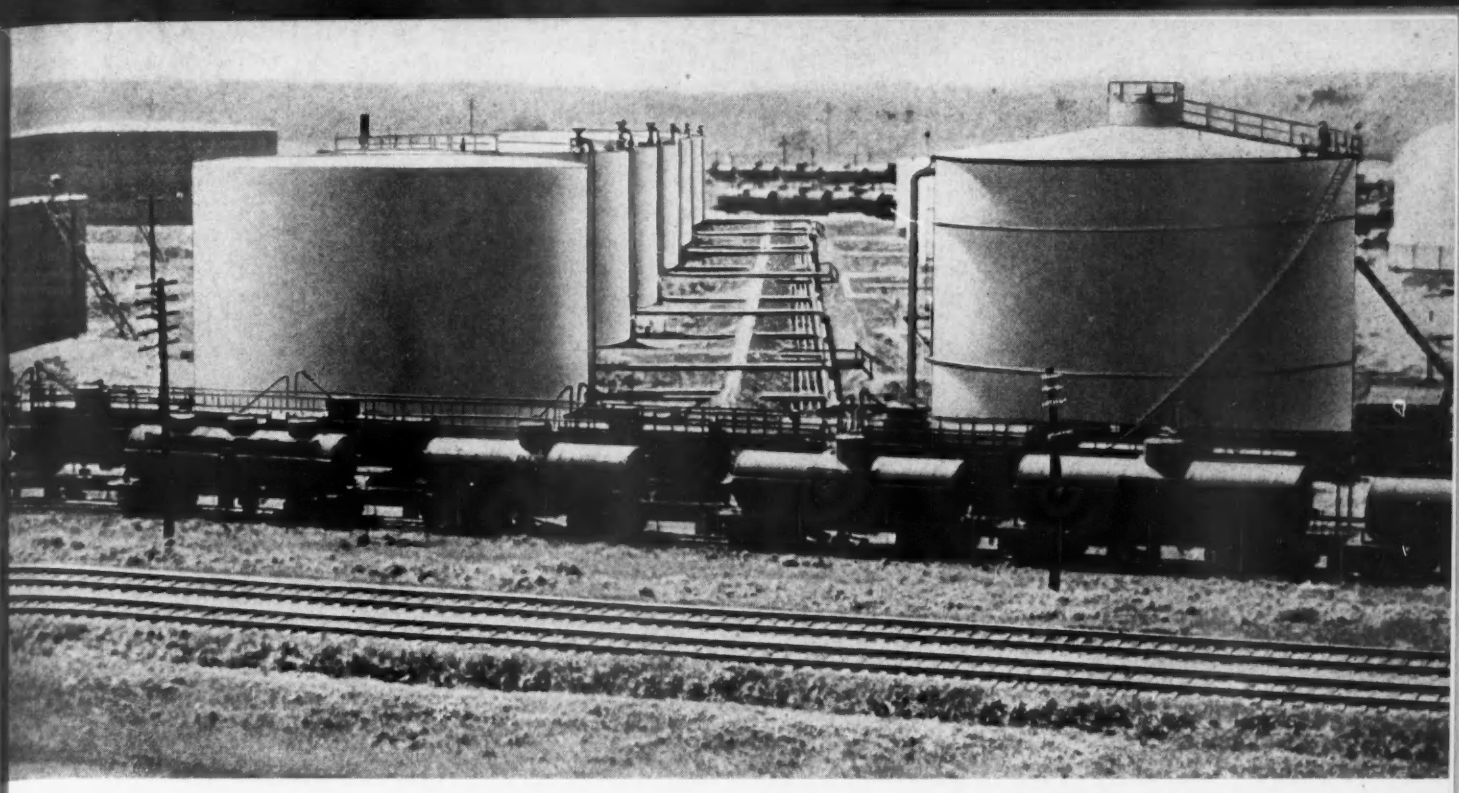
Of ECA's procurement authorizations so far issued, slightly less than one-third each was for procurement in the U. S. and the Middle East, while slightly more than one-third came from other Western Hemisphere sources.

As to the controversial Middle East oil pricing problem, Bransky said that the price of crude oil f.o.b. Persian Gulf ports recently declined by 28 cents a barrel and now is close to the delivered price at American East Coast ports less tariff and competitively determined transport costs from the Persian Gulf. The price is as it should be under competitive conditions he said, and any substantial rise of crude prices above U. S. East Coast prices, less tariff and competitively determined transport cost from Persian Gulf ports, should call for renewed examination by ECA of the price at which it finances shipments of crude from Persian Gulf Ports.

Public Acceptance Sought For Offshore Shooting

Five members have been appointed to a special technical committee to outline a procedure for the future handling of offshore seismic operations so as to minimize the likelihood of unfavorable public relations, according to the Western Oil and Gas Association.

Named to the committee were A. C.



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Formation of the committee was an outgrowth of public relations problems arising from seismic exploration activity off the California coast. The committee will consider also the financing of an independent research project by a recognized educational institution in an attempt to determine further the effect of explosives on marine life and on adjoining land structures.

The Public Relations Committee of the Western Oil and Gas Association also has developed a series of recommendations in connection with the problem. These recommendations include: (1) inauguration of an educational program to explain the nature of and reasons for seismic work; (2) the precautions taken; (3) the objectives sought and the methods used; (4) a request that companies contemplating further seismic activities consult with the association's Public Relations Committee prior to starting such operations; and (5) development of a close liaison with groups interested in beach frontage and development.

Increase in Automobiles To Boost Use of Gasoline

The outlook for motor fuel demand is promising, in view of prospective further heavy production and increasing registrations of motor vehicles. Many automobile industry officials are hopeful that 1950 production will equal or exceed the new record set in 1949. At a minimum, they expect production to remain far higher than prewar levels for many years to come.

Manufacturers start 1950 with heavy demand for motor vehicles in most parts of the country. Dealer stocks of new cars hit the lowest point for the year in the final month of 1949.

In 1949 a record U. S. production of 6,200,000 motor vehicles was achieved, inculding 5,075,000 passenger cars and 1,125,000 motor trucks and buses. The total was 17 percent above 1948 output and 15 percent above 1929's previous record production of 5,358,420 vehicles.

By the end of 1949, U. S. motor vehicle registrations totaled 43,900,000, including 35,700,000 passenger cars, a million trucks, and more than 200,000 motor buses. The total showed an increase of 2,700,000 vehicles or 6.6 percent over 1948 and 9 million vehicles or 25.8 percent over 1941.

Reflecting the wartime interruption of automobile production, the average age of cars on the road remains far above prewar levels. At the end of 1949, the average age of passenger cars in use was 8.4 years, a slight decline from the 8.8 years average age in 1948 and nine years in both 1946 and 1947. Before the war the average age of U. S. passenger cars was 5.5 years.

Oil and Related Industries Of Vast Importance to U. S.

The petroleum industry in the U. S. employs directly 1,880,000 men and women, while 7,915,000 others are employed in related industries that are directly dependent on petroleum industry activities and products for their existence, making a total of 9,795,000 workers depending on petroleum, an API survey revealed. This number represents more than 17 percent of all persons gainfully employed in the U. S. These workers and their families account for 34,282,000 men, women, and children dependent on these industries, or 23.3 percent of the U. S. total population. The survey thus emphasizes the highly important place of petroleum in the nation's economy.

The workers in related industries include 120,000 in petroleum equipment concerns, 757,000 in automotive manufacturing, 1,311,000 in automotive services, 183,000 in aircraft manufacturing, 61,300 with commercial airlines, 15,000 in oil burner manufacturing, 28,500 oil burner dealers and services, 8000 in the motor boat and outboard motors industries, 6000 in motorcycle manufacturing, 135,600 in tractor and power driven farm machinery industries, 5,014,000 in motor truck transportation, 232,000 in bus transportation, 43,600 in other directly related services. Not included in the above totals are additional thousands of workers such as diesel engine and locomotive operators, officers and crews on oil burning ships, workers in chemical and plastics plants, and many other jobs related in one way or another to the use of petroleum products.

Those who work in petroleum and related industries receive wages and salaries of over $27 billion per year or 20.3 percent of the total annual payrolls of $135 billion for all workers in the U. S. They have therefore vast buying power and exert great effect on business and the economy in general. Workers in petroleum production and refining, including many highly skilled technicians, are among the highest paid in the nation, with average annual wages and salaries of $3700. Average annual pay of 1,880,000 oil industry workers, including filling station attendants, is $3077. Combined average annual pay of the 9,795,000 workers in petroleum and related industries is $2804. Average annual pay of all gainfully employed persons in the U. S., including agricultural workers, is about $2368.

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Studies Show Possibilities For Producing Synthetic Oils

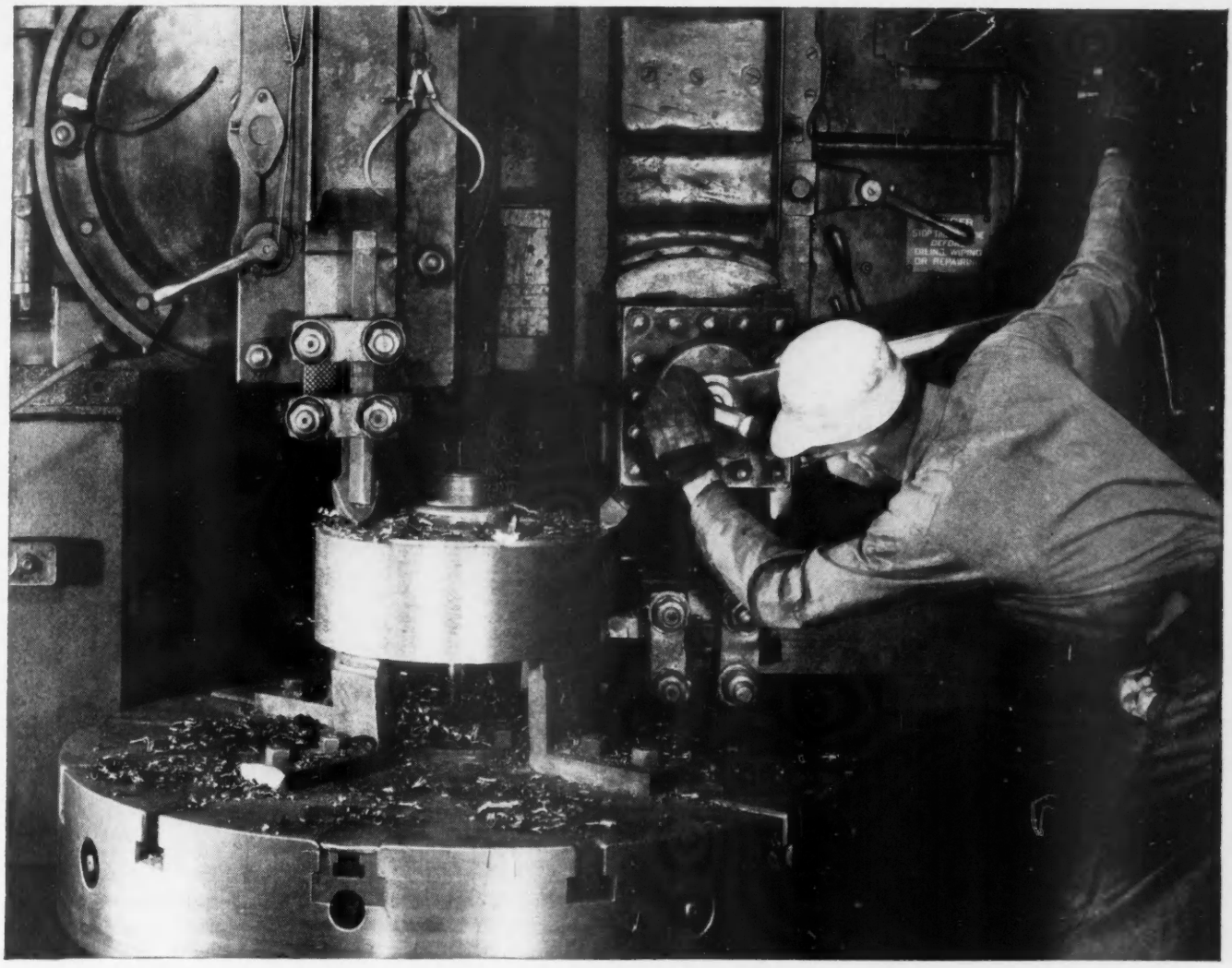
Reports by Army engineers, released by the Bureau of Mines, show that areas suitable for synthetic liquid fuel plants abound in portions of four states covered by two recent sample surveys. Source materials would include coal, oil shale, and natural gas.

In western Kentucky strip and underground coal reserves available for synthetic liquid fuels total 16,768 million tons—enough to supply for 40 years either 138 synthine (modified Fischer-Tropsch) process plants of 10,000 barrels per day capacity each or 164 hydrogenation plants of same capacity.

In northwestern Colorado, oil shale reserves yielding 25 or more gallons per ton without deep shaft mining would support for 40 years approximately 105 oil shale plants each with capacity of 10,000 barrels daily. Available coal reserves would supply 279 synthine plants or 336 hydrogenation plants. Water is a critical resource in this area, however, and supply available by 1963 for all new uses would limit synthetic fuel capacity to 1,050,000 barrels per day from shale plus 510,000 to 840,000 barrels daily from coal, depending on processes used.

In southeastern Montana, mineable coal reserves and water supplies exist to support for 40 years some 362 synthine plants of 10,000 barrels per day capacity each.

In southeastern Texas 9½ trillion cubic feet of natural gas might be converted into synthetic liquid fuels. This would support for 20 years 14 plants of 10,000 barrels a day capacity each. However, says the report, there is a question as to availability of this gas under normal conditions because of economic and conservation considerations. Now being recycled to maintain pressure in petroleum reservoirs, its diversion too soon to other use could involve considerable loss of the natural resources.



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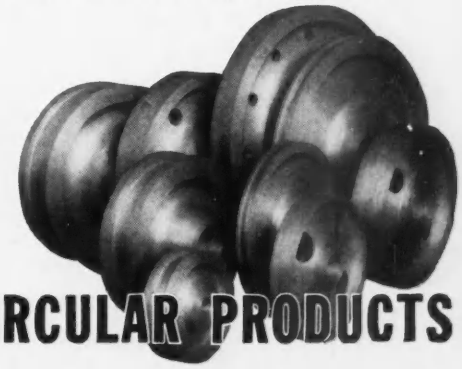

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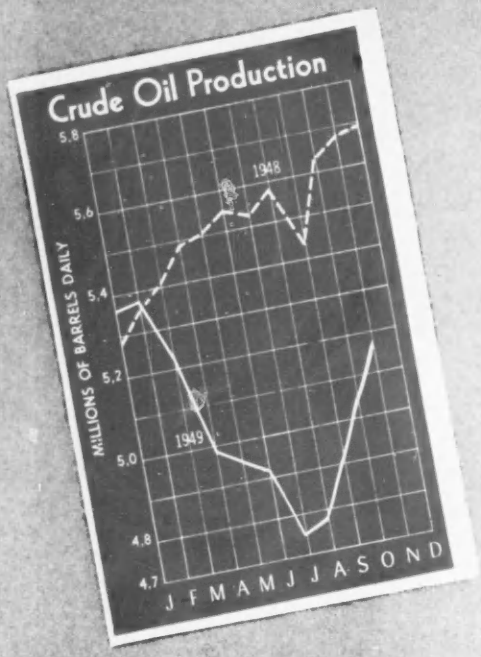
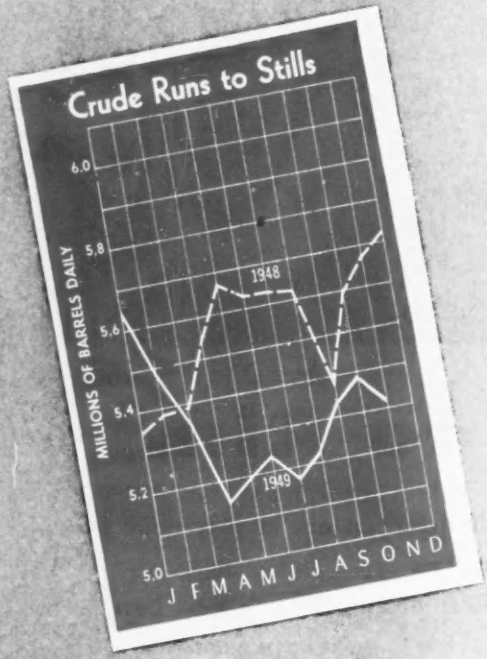
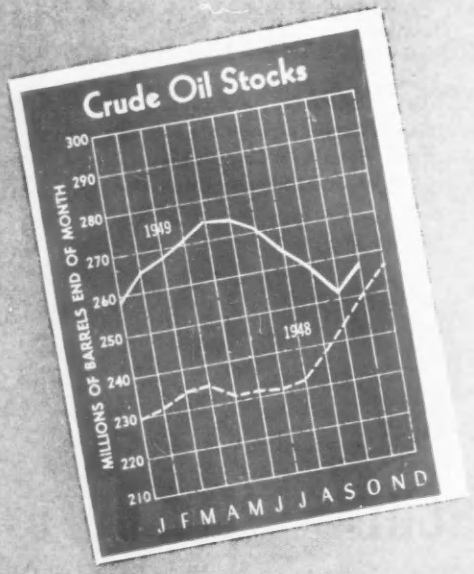






November Production Gains

By CECIL W. SMITH,

CRUDE production was hiked in November for the fourth consecutive month, gaining 120,000 barrels a day to average 5,174,000 daily, the highest level since March, 1949. While this was going on refiners were lowering their operations 67,000 barrels a day. This drop helped some in easing the high product stocks situation, but it also allowed additions to crude stocks, which the industry was not interested in doing.

Had cold weather arrived during the month, refiners would have adjusted their operations to take care of the increased call for fuel oils, thereby making use of the increased production. But cold weather didn't show and as production allowables were already set in the controlled states the result was the swelling of crude stocks. The industry had whittled these inventories to a comfortable 251 million barrels by the end of September, but by the end of November they had jumped back to more than 257 million.

Until normal winter fuel oil consumption occurred, the only answer was to cut back production. That was done at the start of December, with Texas lopping off two days from its production schedule to drop its output for the month about 191,000 barrels a day.

U. S. production in November averaged 5,174,000 barrels a day, a gain of 120,000 daily over October's output, but 501,000 a day less than in November, 1948. Texas alone accounted for almost 108,000 of the 120,000-barrel hike.

Refinery runs to stills amounted to 5,318,000 daily during the month, a decline of 67,000 barrels from the previous month's runs, and 354,000 under runs made in November, 1948. This cut did permit the fuel oil stocks to start downward, but it was not enough to prevent gasoline stocks from making substantial gains. The unfortunate aspect of the necessary cutback in refining was the production hike, which had to go to storage.

At the end of November crude stocks totaled 257,598,000 barrels after gaining 4,943,000 barrels during the period. Since June the industry had been

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1948:									
January	5,283	5,348	229,842	2,328	102,167	1,082	39,788	1,278	36,260
February	5,353	5,380	231,419	2,264	110,999	1,127	33,019	1,295	35,602
March	5,406	5,387	234,164	2,252	111,949	1,050	30,570	1,307	34,192
April	5,484	5,540	234,506	2,396	109,289	978	32,564	1,303	35,527
May	5,502	5,668	231,318	2,486	108,552	992	38,551	1,314	41,123
June	5,544	5,632	231,412	2,529	104,518	998	45,835	1,280	44,213
July	5,522	5,631	230,955	2,494	98,839	994	56,045	1,264	49,448
August	5,577	5,621	231,954	2,532	95,445	1,038	65,887	1,248	55,009
September	5,435	5,376	237,302	2,416	90,518	961	73,854	1,154	58,682
October	5,632	5,594	243,972	2,490	92,426	1,069	79,992	1,268	61,456
November	5,675	5,672	250,066	2,551	95,589	1,081	80,658	1,277	64,865
December	5,688	5,720	256,254	2,626	103,697	1,106	71,475	1,299	64,021
1949:									
January	5,365	5,641	258,648	2,538	116,621	1,063	61,584	1,348	62,508
February	5,376	5,480	265,216	2,484	126,054	1,004	53,937	1,282	59,398
March	5,224	5,352	269,341	2,470	127,443	993	48,923	1,258	58,190
April	5,012	5,141	272,520	2,494	125,351	846	51,231	1,147	59,668
May	4,972	5,195	273,912	2,585	121,602	813	57,442	1,138	63,576
June	4,903	5,162	274,691	2,597	114,041	771	64,730	1,041	64,628
July	4,704	5,173	267,586	2,613	111,217	835	71,553	1,040	66,084
August	4,780	5,241	260,585	2,593	104,879	902	76,037	1,078	66,843
September	4,940	5,427	251,689	2,617	101,799	1,002	83,213	1,110	67,117
October	5,054	5,385	252,655	2,627	104,013	994	90,838	1,086	69,383
November	5,174	5,318	257,598	2,586	105,115	998	90,454	1,147	66,621
Nov., 1949 Change:									
In Month	+120	—67	+4,943	—41	+1,102	+4	—384	+61	—2,762
In Year	—501	—354	+7,532	+35	+9,526	—83	+9,796	—130	+1,756

Trends in U. S.

For Fourth Straight Month

Statistical Editor

successful in slowly working off excessive crude stocks, but part of the efforts was wiped out during November. Cold weather would bring need for refining hikes and thereby call upon these stocks to meet the demand. End of November crude stocks were 7,532,000 barrels more than were in storage a year earlier.

Some increase in demand for the light heating oils was evident during the month. With production held at about the two previous months' level, stocks stabilized and actually showed a slight downward movement. However, these combined stocks totaled 90,454,000 barrels at the end of November which was 9,796,000 barrels more than was in refiners' tanks a year earlier.

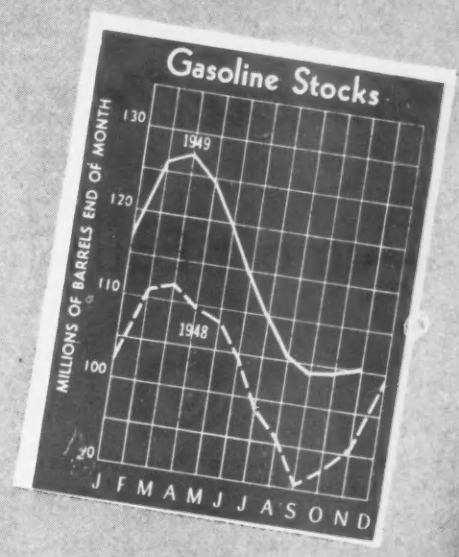
In different circumstances were the heavier residual oils whose stocks at the end of the month were only 1,756,000 barrels greater than those of a year before. Actually, there were considerably less residual stocks east of the Rockies than there were a year ago, as California has added about 13 million to the U. S. total. Some areas have even felt some scarcities of this product.

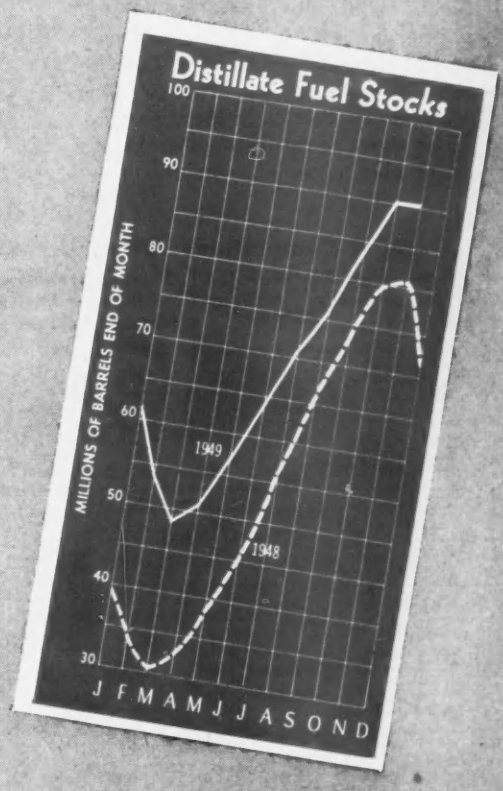
Gasoline continued to accumulate and ended the month at 105,115,000 barrels. Although a small cut of 41,000 barrels a day was made in gasoline production, stocks grew 1,102,000 barrels and were at the end of the month 9,526,000 barrels larger than they had been a year before.

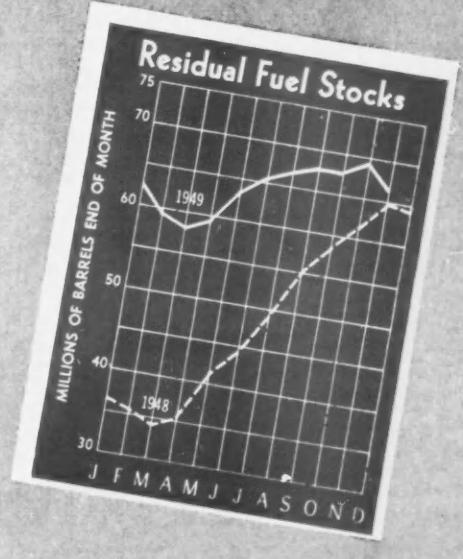
State Crude Oil Production

(THOUSANDS OF BARRELS)

STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL FIRST ELEVEN MONTHS		
	November, 1949	October, 1949	November, 1948	% Diff. November, '48-'49	1949	1948	% Diff. '48-'49
Alabama	1.3	1.3	1.3	.....	412	428	— 3.7
Arkansas	77.8	76.3	88.2	— 11.8	27,005	28,988	— 6.8
California	868.3	884.7	953.2	— 8.9	306,059	310,652	— 1.5
Colorado	64.1	64.3	47.0	+ 36.4	22,016	15,502	+ 42.0
Florida	1.0	0.9	0.6	+ 66.7	412	262	+ 57.3
Illinois	181.4	182.2	180.4	+ 0.6	59,268	59,161	+ 0.2
Indiana	28.5	28.6	22.0	+ 29.5	8,596	6,011	+ 43.0
Kansas	284.5	268.7	302.5	— 6.0	92,821	101,086	— 8.2
Kentucky	24.9	23.6	23.7	+ 5.1	7,763	7,829	— 0.8
Louisiana	551.7	548.9	517.1	+ 6.7	173,954	165,038	+ 54
North Louisiana	125.6	124.2	123.8	+ 1.5	40,813	39,591	+ 3.1
South Louisiana	426.1	424.7	393.3	+ 8.3	133,141	125,447	+ 6.1
Michigan	44.6	45.3	48.1	— 7.3	14,994	15,366	— 2.4
Mississippi	99.1	99.4	132.5	— 25.2	34,887	41,853	— 16.6
Missouri	0.1	0.2	0.1	.....	45	48	— 6.3
Montana	24.1	24.9	26.3	— 8.4	8,472	8,581	— 1.3
Nebraska	1.2	0.9	0.8	+ 50.0	253	216	+ 17.1
New Mexico	131.0	125.6	135.8	— 3.5	43,680	43,737	— 0.1
New York	13.3	13.6	12.9	+ 3.1	4,041	4,235	— 4.6
Ohio	9.0	9.7	9.1	— 1.1	3,156	3,019	— 4.5
Oklahoma	425.4	419.2	436.8	— 2.6	138,457	140,075	— 1.2
Pennsylvania	26.9	27.4	34.9	— 22.9	10,291	11,647	— 11.6
Tennessee	.....	0.1	.....	.....	16	7	+128.6
Texas	2,178.5	2,070.9	2,543.8	— 14.4	682,896	824,180	— 17.1
Dist. 1—South Central	27.3	27.5	27.7	— 1.4	8,883	9,169	— 3.1
Dist. 2—Middle Gulf	133.1	128.6	180.2	— 26.1	43,854	58,734	— 25.3
Dist. 3—Upper Gulf	415.8	405.8	517.5	— 20.2	133,208	167,362	— 20.4
Dist. 4—Lower Gulf-S.W.	205.3	198.2	257.4	— 20.2	66,113	85,125	— 22.3
Dist. 5—East Central	37.5	35.7	52.1	— 28.0	12,498	15,888	— 21.3
Dist. 6—Northeast	366.0	344.3	426.0	— 14.1	117,568	144,056	— 18.4
Dist. 7-B—N. Central	63.1	63.1	58.2	+ 8.4	20,243	16,373	+ 23.6
Dist. 7-C—West Central	54.9	51.8	48.9	+ 12.3	15,583	15,062	+ 3.5
Dist. 8—West	639.6	584.3	746.7	— 14.3	192,499	232,420	— 17.2
Dist. 9—North	143.6	139.5	142.6	+ 0.7	45,031	46,851	— 3.9
Dist. 10—Panhandle	92.3	92.1	88.7	+ 4.1	30,390	29,107	+ 4.4
Utah	2.5	2.4	.....	.....	374	.....	.....
Virginia	0.1	0.1	0.1	.....	38	30	+ 26.7
West Virginia	8.0	8.5	7.7	+ 3.9	2,592	2,467	+ 5.1
Wyoming	126.6	126.1	149.8	— 15.5	42,755	49,535	— 13.7
Total United States	5,173.9	5,053.8	5,674.7	— 8.8	1,685,253	1,839,953	— 8.4







Completions

Almost Equal 1948 Record

WELLS completed in November hit a new high for the year of 3675 and brought the over-all total almost up to the 1948 record. For the past several months completions have trailed those of 1948, but with November's increased activity and indications that December would prove quite active, the two years' totals should be nearly the same.

The above comparison concerned only the number of wells completed, but to get a truer picture of total activity the amount of hole drilled must be viewed. It is in this department that 1949 will far outreach the previous year. At the end of 11 months, there had been about 4⅓ million feet more drilled in 1949 than in the comparable period of 1948. As the number of wells were practically the same, the 1949 wells had to be deeper on the average. Actually, each new well averaged 3575 feet, while in 11 months of 1948 they had been carried to 3454 on the average.

The greatest amount of footage ever drilled in a single year was in 1948, when slightly more than 135 million was recorded. However, 1949 should beat that record by almost 4 million, and also set a new high in average depth per well. The average depth record was set in 1945, when each well averaged 3489 feet. Wells in 1948 hit 3470 each and those in 1949 should reach considerably deeper than 3500.

November's upswing in activity boosted the year's 11-month total to within 24 wells of the previous year's 11-month total that went on to set a new all-time mark. At the end of November, the industry had completed 35,815 wells as against 35,839 a year before.

Normally the last two months of a year see drilling cutbacks because of cold weather, but such has not been the case in the past two years. December this year started with an increased number of active drilling rigs, has had favorable weather, and should give a strong finish to the year's drilling program.

Well Completions in the United States During November, 1949, and Cumulative for Year

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from *The Producers Monthly*)

STATE or DISTRICT	MONTHLY COMPLETIONS, NOVEMBER, 1949									TOTAL COMPLETIONS				CUMULATIVE TOTAL				Rigs in Operation (Drilling, Rigging Up and Shut Down)		
	NEW WELLS																			
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New	Total Drilled Deeper	Nov., 1949	Oct., 1949	Nov., 1948	Footage November, 1949	Wells 1949	Wells 1948	Percent Diff.	Footage 1949	Nov. 30, 1949	Oct. 31, 1949	Nov. 30, 1948
Alabama				1				1		1	2	2	3,337	15	18	— 16.7	72,011	4	3	5
Arizona											1			5	1	+400.0	15,603	4	4	7
Arkansas	18			12				30	1	31	32	33	99,350	305	298	+ 2.3	1,213,462	26	27	34
California	143		7	49				199	13	212	178	216	859,794	2,335	2,422	— 3.6	9,333,352	227	254	272
Colorado	1			4				5		5	7	8	29,748	62	192	— 67.7	276,860	17	22	30
Florida				1				1		1	3	1	5,517	17	25	— 32.0	114,224	4	4	6
Georgia														4	3	+ 33.3	12,437	1	1	
Illinois	117		2	123				242		242	294	212	509,543	2,422	2,256	+ 7.4	5,734,272	255	225	278
Indiana	45			69				114		114	125	117	227,108	1,144	997	+ 14.7	2,122,223	143	135	136
Kansas	143		57	134	1		2	337		337	276	240	1,092,979	2,840	2,733	+ 3.9	9,368,702	303	310	317
Kentucky	39		24	39				102		102	93	53	183,900	876	704	+ 24.4	1,610,430	93	98	76
Louisiana	115	13	23	63	1			215		215	180	185	1,099,159	2,098	2,043	+ 2.7	11,274,471	241	229	208
North Louisiana	75	7	23	35	1			141		141	110	101	459,505	1,270	1,330	— 4.5	4,096,412	82	86	68
South Louisiana	40	6		28				74		74	70	84	639,654	828	713	+ 16.1	7,178,059	159	143	140
Maryland											1			1	1		4,900			
Michigan	40		3	38				81		81	71	59	201,699	851	674	+ 26.3	1,947,963	140	142	111
Mississippi	6	1		11				18		18	39	39	124,046	311	399	— 22.1	2,273,078	38	32	39
Missouri	1		2	1				4		4	7	3	1,130	26	51	— 49.0	12,249	10	7	9
Montana	14		3	3				20		20	30	34	48,591	244	289	— 15.6	601,190	43	36	46
Nebraska	1			2				3		3	4		13,331	14	1	+1300.0	59,947	6	3	
Nevada																				1
New Mexico	28		5	10				43	1	44	44	40	198,653	480	554	— 13.4	2,098,314	103	96	125
New York	59			1	37			97		97	51	142	136,148	856	1,673	— 48.8	1,223,308	95	80	187
North Dakota				1				1		1	1		3,222	4			18,030	1	2	1
Ohio	39		25	31				95	3	98	90	117	197,176	968	1,246	— 22.3	2,055,171	169	154	218
Oklahoma	271	2	22	170	4		1	470	10	480	362	332	1,646,830	4,066	3,822	+ 6.4	14,389,039	545	523	537
Pennsylvania	49		47	19	38	16		169		169	145	292	322,934	1,851	3,075	— 39.8	3,350,794	248	229	410
South Dakota											1			3	1	+200.0	10,041	2	2	2
Tennessee												15		27	53	— 49.1	27,001	7	7	9
Texas	787	16	76	362	1	4		1,246	22	1,268	1,165	1,127	5,234,896	12,915	11,035	+ 17.0	53,376,810	1,384	1,295	1,476
Dist. 1—S. Central	22		1	25				48	2	50	37	33	133,624	512	450	+ 13.8	1,544,369	39	35	39
Dist. 2—Middle Gulf	20	5	12	15				52	1	53	46	55	312,305	598	679	— 11.9	3,499,414	51	51	53
Dist. 3—Upper Gulf	90	6	4	48				148	1	149	112	121	854,700	1,273	1,017	+ 25.2	7,603,825	136	115	131
Dist. 4—Lower Gulf-SW	56	3	10	40				109	5	114	91	143	563,813	1,231	1,305	— 5.7	6,114,572	100	95	131
Dist. 5—E. Central	1	2	1	7				11		11	13	25	48,890	179	215	— 16.7	837,474	24	29	30
Dist. 6—Northeast	48		2	12				62	1	63	62	43	296,047	815	372	+119.1	3,604,087	43	48	45
Dist. 7-B—N. Central	91		3	76		3		173		173	144	142	500,717	1,759	1,328	+ 32.5	5,187,045	175	188	210
Dist. 7-C—W. Central	39		1	20				60	6	66	48	37	264,603	455	373	+ 22.0	2,012,630	86	83	67
Dist. 8—West	233		2	31	1			267	5	272	260	228	1,314,688	2,670	2,692	— 0.8	13,090,801	459	372	459
Dist. 9—North	139		1	82		1		223	1	224	240	214	658,734	2,411	2,045	+ 17.9	6,620,604	173	169	135
Dist. 10—Panhandle	48		39	6				93		93	112	86	286,775	1,012	559	+ 81.0	3,261,989	98	110	173
Utah	1			1				2		2	5	1	10,434	53	18	+194.4	268,294	12	13	12
Virginia				1				1		1			7,401	1	1		7,401	1	1	
Washington															2	—100.0		1	1	
West Virginia	20		31	20				71	1	72	37	73	187,773	461	768	— 40.0	1,315,273	256	222	370
Wyoming	31		1	25				57		57	56	57	275,186	560	484	+ 15.7	2,634,747	106	90	138
Total U. S.	1,968	32	328	1,191	82	20	3	3,624	51	3,675	3,300	3,398	12,719,885	35,815	35,839	— 0.1	126,821,597	4,485	4,247	5,060

Looking Ahead

CONSENSUS OF FORECASTERS is that 1950 will be a good year for business generally, although not quite as good as 1949 and almost certainly not equal to record-setting 1948. First half of 1950 looks definitely favorable, but unfavorable factors may become more dominant in latter half, causing deterioration of situation. Such important activities as construction and automotive production likely will hold close to 1949 levels and do much to sustain business generally. But postwar backlogs of demand have been largely wiped out. Exports will further decline. Farm income, down some in 1949, will further decline moderately in 1950. Jobs will be somewhat harder to get.

RESULTS IN 1950 may be relatively better for petroleum industry than for business in general, due to additional growth of demand for petroleum products, especially gasoline, with more motor vehicles expected to be in use. In 1949, total demand for all oils almost equaled the record set in 1948, with domestic use at a new high but with exports lower. In 1950, the total demand is expected to set a new record, for while exports likely will further decline, domestic consumption may be about 2 percent above 1949. Oil industry prices have been fairly stable for several months, following reductions for fuel oils and heavy crudes, and it is felt that any changes in 1950 should be moderate.

INCREASINGLY INSISTENT DEMAND for curbing U. S. oil imports may be expected, with some large companies joining smaller concerns and independent operators in protest against current and prospective import rates. Illustrative of the growing and widening opposition to heavy imports was the recent statement of Dr. R. E. Wilson, Standard Oil Company (Indiana) board chairman, sent to House Small Business Oil (Keogh) Subcommittee. Wilson said, "I believe a reduction in imports below present levels, and especially below those projected for next year, is clearly indicated." He stated that imports are "in part supplanting domestic production instead of being confined to a purely supplementary role." He opposed legislation to limit imports by quotas, but exhorted major importers to cut imports through "statesmanlike" voluntary action.

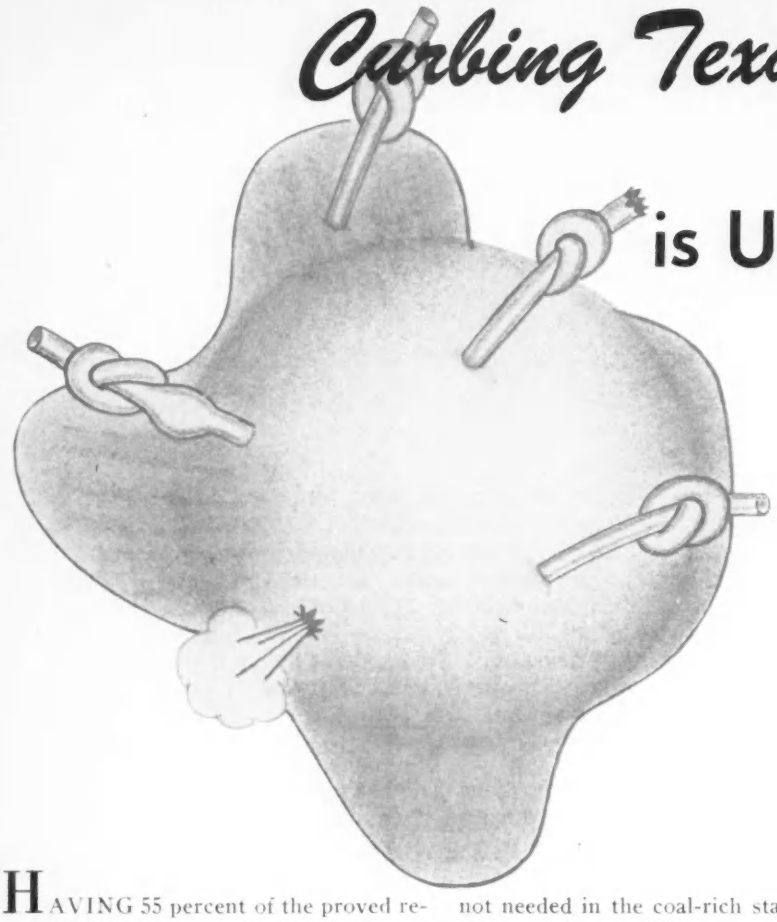
PLENTY OF WORLD TANKER CAPACITY is assured for immediate future. Recent report by Benedict Saurino, Sun Oil Company, showed that as of September, 1949, there were under construction or on order 360 tankers of 6,250,000 deadweight tons and average speed of 14.3 knots. These new tankers will be equivalent in capacity to 27 percent of world tanker fleet capacity existing in September, 1949.

CANADA'S OIL RESERVES probably will increase to 2 billion barrels by early 1951, Dr. O. B. Hopkins, vice president of Imperial Oil, Ltd., has predicted.

RULING BY U. S. SUPREME COURT on validity of U. S. claims to tidelands gradually draws nearer. Court has scheduled for February 6 oral arguments in federal government's tidelands suits against Texas and Louisiana.

FOUR POOLS IN SCURRY COUNTY, West Texas, may prove to be parts of a single, "giant, billion barrel" pool, stated Ernest O. Thompson of Texas Railroad Commission. He cited development of this pool as outstanding oil event of 1949 in Texas and said its productive area now covers 40,000 to 45,000 acres, with north and south ends still open.

Curbing Texas Gas Exports is Unsound Proposal



By

L. J. LOGAN
Associate Editor

and

J. E. KASTROP
Gulf Coast District Editor

HAVING 55 percent of the proved reserves of natural gas in the U. S. and accounting for 45 percent of the country's net production, Texas stands head and shoulders above other states as a supplier of natural gas. The state consequently has been a favored source toward which interstate pipe lines have turned in building new lines to supply large markets in the Northeast and the Middle West.

The vast postwar expansion of natural gas pipe line systems, based largely on Texas gas, has been witnessed with disapproval as well as with approval. Producers and royalty owners generally have welcomed the new and widening markets for their gas and the better prices being offered by the new purchasers. Conservation authorities have found the better prices and markets a potent influence for stopping the wastage of gas.

But there has been also much questioning and adverse criticism of this building up of "export" markets for Texas gas. Restriction of the export of natural gas from Texas is advocated by various groups and on different grounds. It is urged by some politicians, competing industries, various business interests, self-appointed guardians of Texas natural resources, and would-be promoters of Texas industrialization. Some say that the export of Texas gas should be stopped through legislation, and others advise the discouragement of such shipments through taxation.

Keep Texas gas in Texas, because it is not needed in the coal-rich states of the East and Middle West and would damage those states, urge coal mining and coal-hauling railroad interests and labor unions. They voice their arguments in opposing construction of new gas transmission pipe lines from Texas. Keep Texas gas in Texas for the present and future use and industrial advancement of the state, advocate some groups of Texans. As a cheap fuel, gas will attract new industries to the state, they assert. If gas is to be sent out of the state, some advise, then increase the tax on it and let out-of-state consumers have it only by contributing to the state's revenue.

These and similar views and proposals have been discussed in Texas newspapers. They have been heard in the Texas legislature and will be heard there again. Also, it has been indicated that curbing of Texas gas exports may be made an issue in the state's gubernatorial race in 1950.

Full consideration of the facts involved leads to the conclusion that restriction or discouragement of Texas gas exports through legislation or taxation would be short-sighted, unwise, legally questionable, and economically unsound. Restricting the exports would hurt rather than help the state industrially and economically, provide no material benefit to Texas gas consumers, and needlessly withhold supplies from out-of-state consumers. It would depress the market value of Texas gas, reduce investment and employment not only in the gas and oil industries but also in related industries, encourage waste of gas, cut income of thousands of land and royalty owners, without lowering gas costs for most Texas users, and fail to attract new industries to Texas because fuel rarely is a determining factor in selecting the location of an industrial plant. Limiting exports to assure adequate reserves for Texas use in the future is unjustified, as

RESTRICTION OF INTERSTATE MARKETING of Texas natural gas, proposed by various individuals and groups, would be economically unsound and legally questionable. Exports have promoted a healthy, growing Texas gas industry, which benefits Texas primarily and other states incidentally. Contributing materially to increased markets and better prices for Texas gas, the exports have promoted conservation practices, utilization of previously wasted casinghead gas, and development of remarkably large reserves.

(Statistics here used in text and charts, covering natural gas production, consumption, and interstate movement, are from U. S. Bureau of Mines. Those on gas reserves are from American Gas Association.)

Texas reserves are fantastically large and growing, while other states also are increasing their reserves. Actually, future markets may be less certain than future supplies. And if Texas does not take advantage of available markets, it may eventually see them diminish through competition of other fuels and natural gas from other states, which even now are importantly competing with Texas in the interstate market for natural gas.

Free and competitive exports of Texas gas, on the other hand, already have demonstrated their soundness and desirability. They have contributed decisively to increased markets and better prices for Texas gas. The expanding markets and improving prices have promoted conservation practices, elimination of gas wastage, establishment of related industries, and discovery and development of additional gas reserves. The exports have helped greatly to establish a healthy, growing Texas gas industry which benefits Texas primarily and other states only with dividends to Texas. This thriving Texas gas industry is the basis for much employment and large investment not only in gas producing operations, but also in related industries, the state ranking first not only in gas production, reserves, and gas wells but also in casinghead gas output, investment in gas treating plants, natural gasoline, liquefied petroleum gas, carbon black, miles of natural gas pipe lines, and natural gas consumption.

In the past, the Texas gas industry was primarily an adjunct or appendix to the oil industry. Gas wells and gas reserves, secured in drilling for oil, were of relatively low value because of limited markets for gas. But because interstate as well as intrastate pipe lines are opening up large new markets and are putting increased values on gas reserves, the Texas gas industry now is assuming an independent status, becoming itself an important industry.

Price Rise

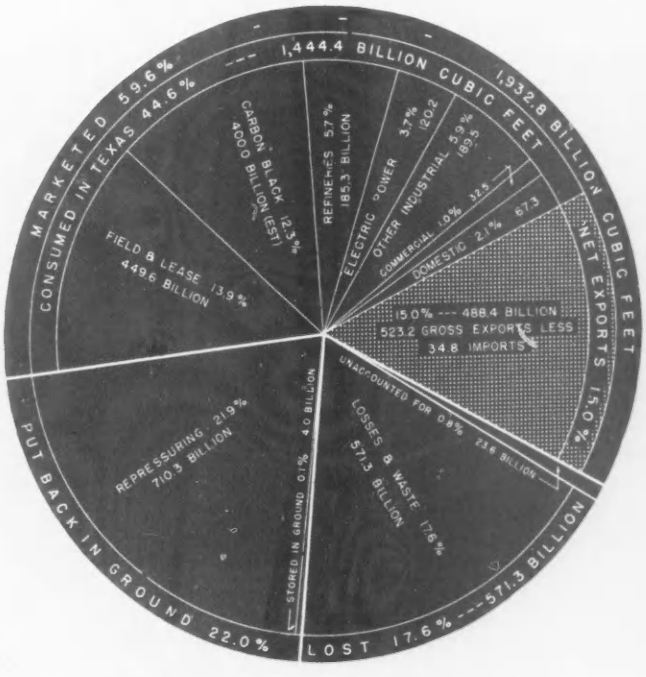
Steady improvement in wellhead prices of Texas gas in recent years has been caused in large part by increased demand for the export market. Gas within reasonable distances from interstate pipe lines has been selling in 1949 for as much as ten cents per thousand cubic feet. Official figures from the Texas State Comptroller of Public Accounts show that the average price for all kinds of natural gas at the well in Texas rose from 3.209 cents per thousand cubic feet in 1945 to 3.378 cents in 1946, 4.363 cents in 1947, and 5.330 cents in 1948, and it is estimated that the price averaged 6.5 cents in 1949.

Moreover, this better deal for natural gas producers and royalty owners, except in rare cases, has not increased the price of natural gas to Texas consumers. This is because Texas consumers for the most part are being supplied out of gas available on old long contracts at a lower price at the well. It is the new export gas which goes at the higher price.

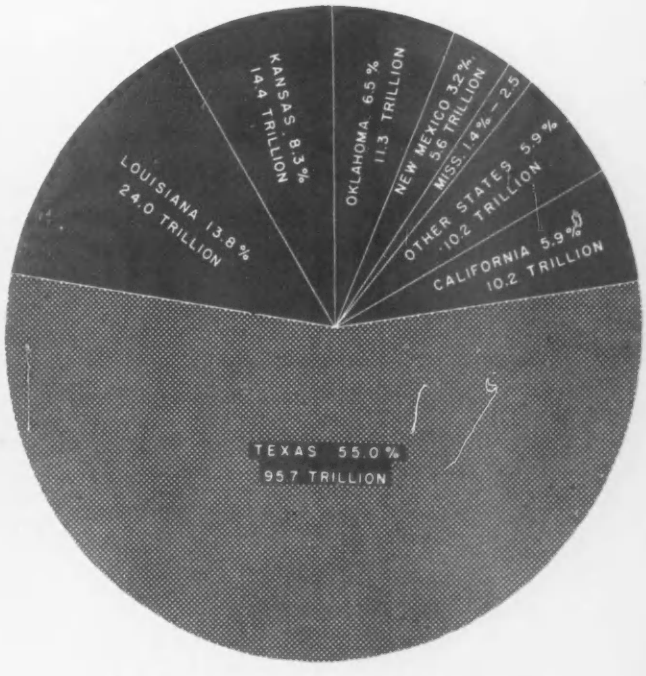
Instead of making inroads into Texas reserves and depriving Texas consumers of supplies, the interstate sales are stimulating discovery and development of more than compensating reserves, and there is plenty of Texas gas for both Texas and non-Texas use. While Texas holds 55 percent of U. S. gas reserves, it has been providing only about 45 percent of U. S. net production. Since data on reserves were initiated several years ago, both Texas and the U. S. have shown net increases in reserves each year despite expanding production. In 1948 Texas had net production of 2.7 trillion cubic feet, but 8.4 trillion feet of new Texas reserves were proved up during the year, covering the year's production and providing in addition a net increase of 5.7 trillion feet to Texas proved reserves. The 95.7 trillion cubic feet of proved reserves at the end of 1948 represented the largest Texas reserves on record, and on the basis of the 1948 net production of 2.7 trillion feet, were equivalent to 35.4 years' supply. In contrast, Texas crude oil reserves of 12,484,218,000 barrels at the end of 1948 represented only 13.8 years' supply on the basis of 1948 production of 903,318,000 barrels. The state therefore is much better situated on gas reserves than on reserves of oil, which Texas gladly exports to the extent of an estimated 80 percent of the total produced. If the state produced only the oil it consumed, its oil industry would virtually dry up. No one with a full understanding of the oil industry and the economics of the nation and the state would propose restricting the movement of oil from Texas into other states. Even the opponents of exporting Texas gas would not propose such a preposterous measure.

Texas definitely is not running out of gas. On the contrary, both Texas and the U. S. have been regularly increasing their known reserves and now hold record-breaking reserves. New discoveries of natural gas in Texas and the nation in 1949 indicate that reserves at the end of 1949 will be higher than at the end of 1948.

There is abundant geological opinion



Disposition of gas produced in Texas in 1947.
(Gross production 3242.0 billion cubic feet.)



U. S. reserves of natural gas, end of 1948, by states.
(U. S. total 173.9 trillion cubic feet.)

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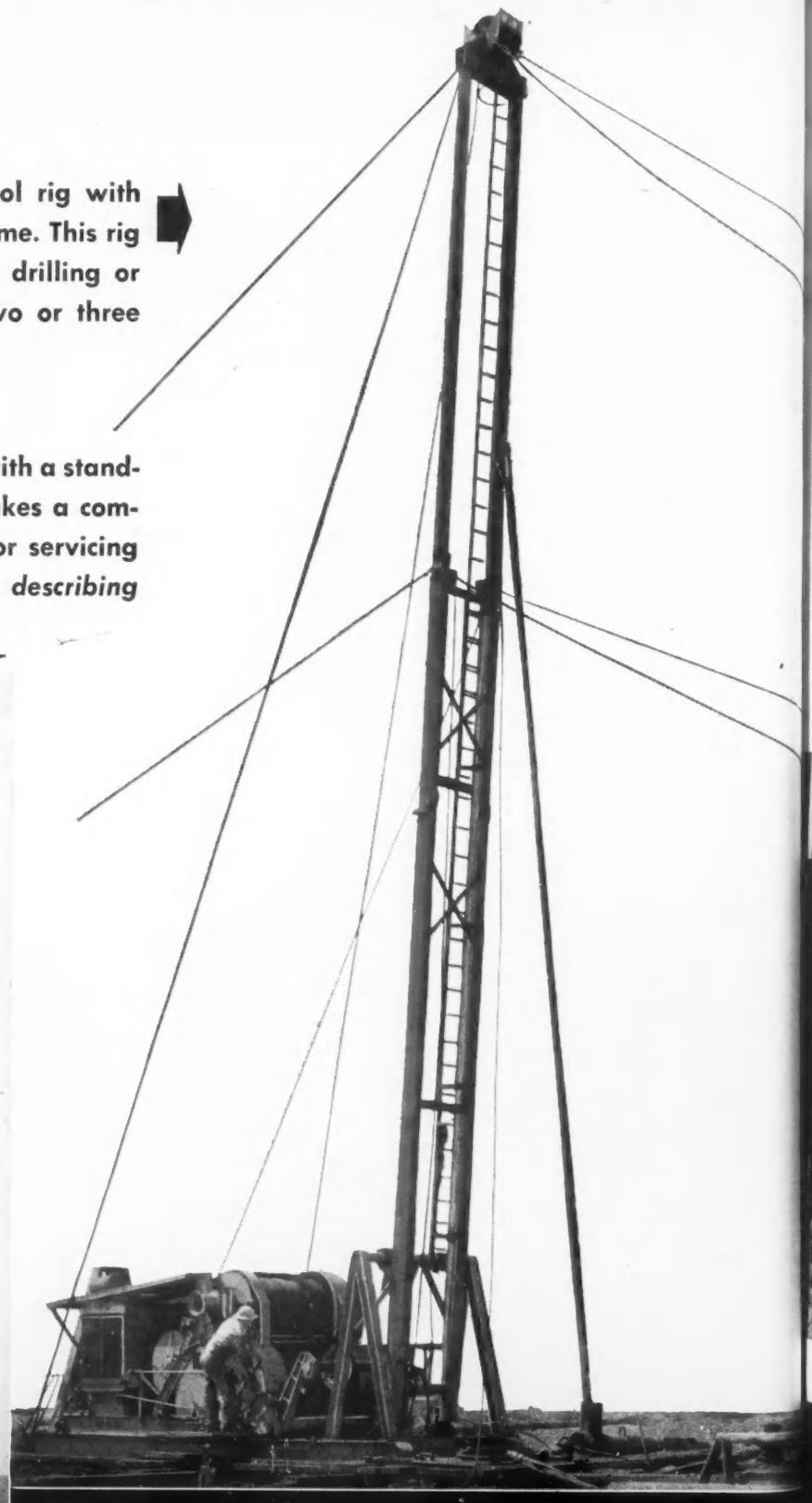

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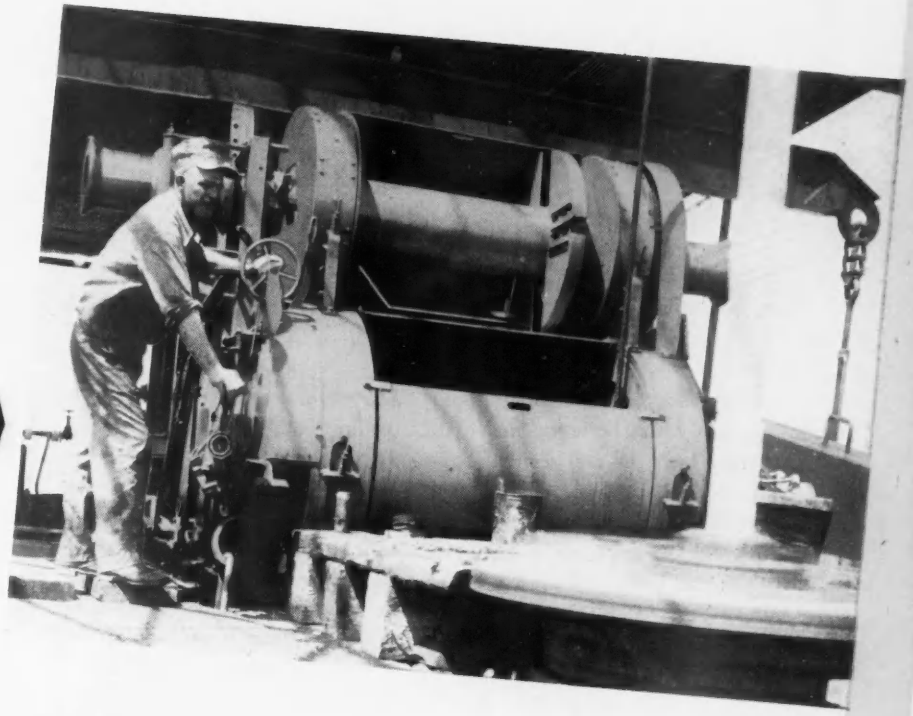
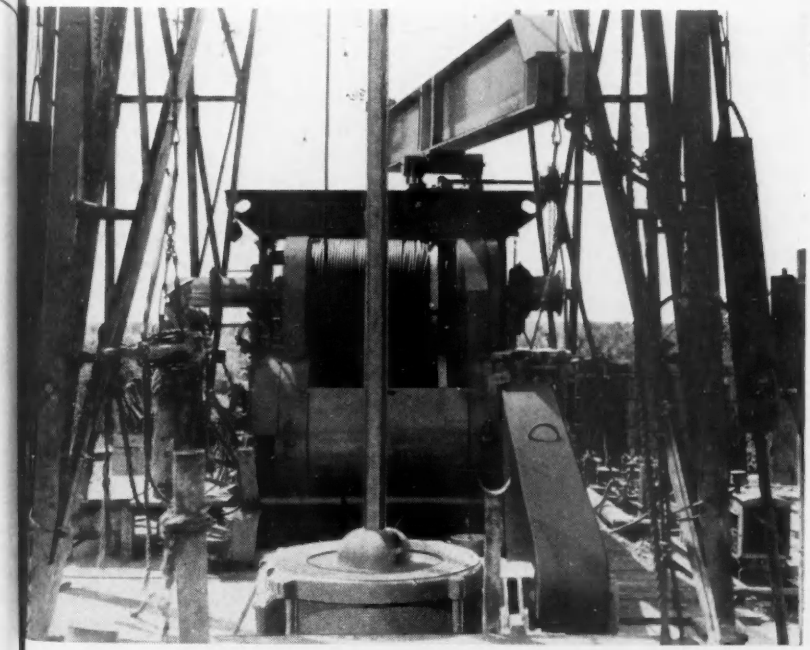
Model R equipped as a double drum draw works. This is the same basic rig as the double spudder shown on the opposite page. The rotary rig can be changed over to cable tool operations to "tail in" for a better producing well in low pressure areas.





A Model R equipped with rotary drive and a beam assembly. Both assemblies are in place and ready for use in a few minutes. No change in equipment is necessary to switch from rotary to cable tools. The heavy-duty beam is ideal for cable tool drilling and pumping potentials. The complete rig can be easily transported on a truck or trailer.

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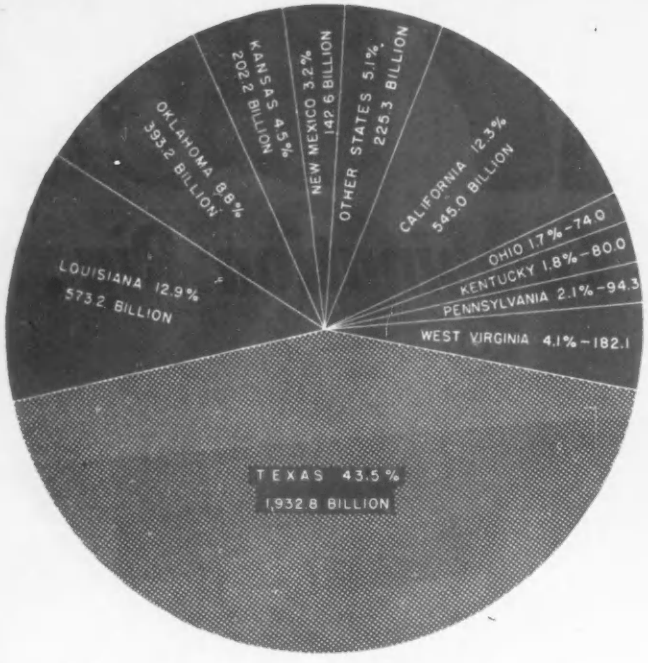
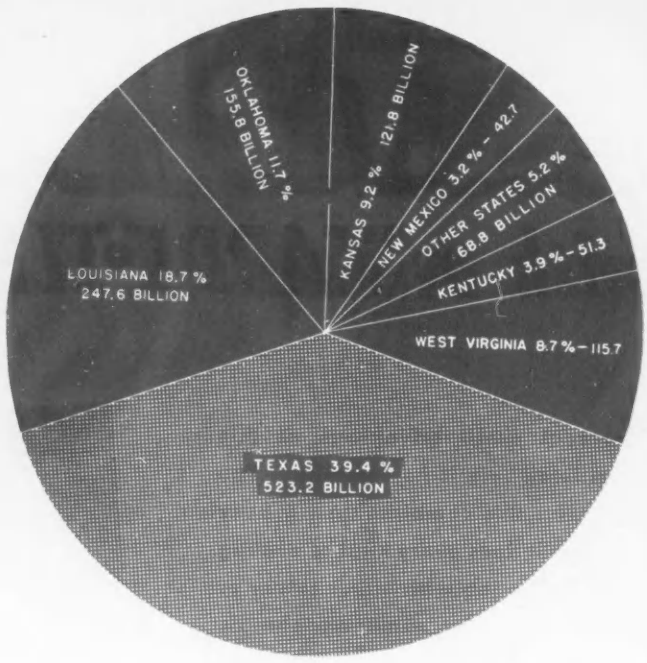


U. S. natural gas marketed production, by states, in 1947. (U. S. total 4444.7 billion cubic feet.)



Interstate transportation and exports of natural gas from producing states of U. S. in 1947. (U. S. total 1326.9 billion cubic feet.)

which holds that more petroleum and natural gas are yet to be found in North America than have so far been discovered. It is noteworthy, too, that as oil and gas wells are completed at increasing depths, the proportion of gas and gas-distillate wells increases. Also, the potentials of the deeper gas wells seem to be higher.

Another very important consideration regarding Texas gas reserves is the fact that increased demand for gas, caused materially by exports, is in effect conjuring up extra supplies from the thin air. Large volumes of casinghead gas, produced along with oil from oil wells, formerly were burned in flares for lack of markets or other means of disposal but now are being saved and put into pipe lines. Currently, net exports of Texas gas are only slightly greater in volume than the state's marketing of casinghead gas from oil wells.

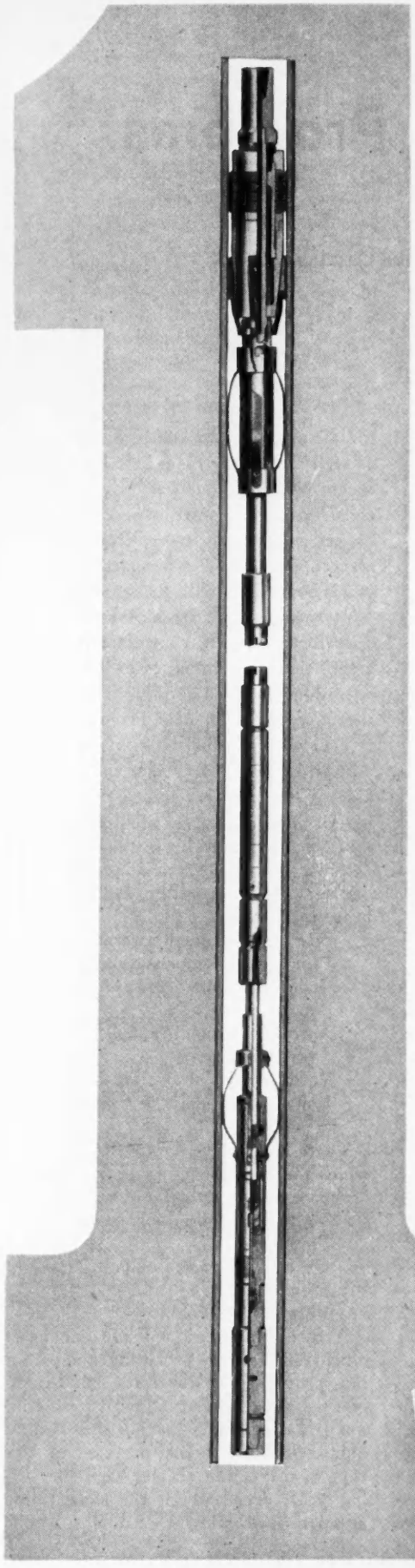
Actually, the proportion of natural gas produced in Texas which is exported is much smaller than generally realized. In 1947, for example, net exports were 488,435 million cubic feet, (523,182 of gross exports less 34,747 of imports). These net exports were only 15 percent of the 1947 gross production of 3,242,000 million cubic feet; or 19.3 percent of the net production of 2,527,713 million (gross less 714,287 put back in the ground—710,302 in repressuring and 3985 for storage); or 25.3 percent of the 1,932,857 million cubic feet of marketed production (net less 571,309 losses and waste and 23,547 unaccounted for). This marketed production included 488,435 million cubic feet of net exports and 1,444,422 consumed in Texas (67,267 for domestic use, 32,508 for commercial use, 449,574 for drilling, pumping, and other field and lease use, 185,298 at oil refineries, 120,179 at electric public utility power plants, and 589,596 for other industrial use, here estimated to have included 400,000 at carbon black plants, 18,000 at cement plants, and 171,596 for other purposes). Of the 1,932,857 million cubic feet actually marketed or consumed, it is estimated that 22 percent or 425,228 million may be credited to casinghead gas. In effect, therefore, the state has been exporting not much more than its casinghead gas—the gas which for years burned in flares over the state's oil fields because saving it was not economically justified.

Recent conservation measures have eliminated most flaring of casinghead gas. Fundamentally, such conservation has become possible because present higher prices for gas justify the investments and the expense of gathering, treating, and compressing of casinghead gas. While natural gasoline and cycling plants derive revenue from natural gasoline, liquefied petroleum gases, and other liquids extracted from the casinghead gas, they are made more feasible by markets and worthwhile revenue also for the remaining dry or residue gas. Through these plants, Texas is enabled to recover commercially both the valuable liquids and the gas contained in the casinghead gas. The wet gas of this kind accounted for a material part of the Texas reserves of 95.7 trillion cubic feet of gas and 2 billion barrels of natural gas liquids at the end of 1948. Restriction of exports of Texas gas, much of which is residue gas from the plants processing casinghead gas, would curtail production of the natural gas liquids as well as the gas. Landowners and operators would lose income, and the state would lose taxes now collected on production of these natural resources.

Instead of worrying about the adequacy of gas for use in the distant future, some far-sighted leaders in the natural gas industry are more concerned over whether there will be markets for natural gas 20 to 30 years from now. For there are other energy sources which must be recognized. Converting coal and lignite in place in the earth into a gas equivalent to natural gas is probable. Within 20 years natural gas may be under competitive pressure from coal gas for markets. Atomic fission as a huge energy source in commercial use within two decades, displacing billions of cubic feet of gas, also is possible. So swift are technological developments that conversion of solar energy commercially at any time would not be surprising. More commonplace are the growing uses of electricity for home and other installations in competition with natural gas. It should be remembered that the electric light bulb replaced the gas mantle.

For Texas gas there is also a more direct competition, offered by the natural gas of other states. While Texas ranks first among the states in reserves, production, and interstate shipments, it directly competes for markets with the neighboring states of Louisiana, Oklahoma, Kansas and New Mexico. Of the U. S. natural gas reserves of 173.9 trillion cubic feet at the end of 1948, those four states held 55.3 trillion or 31.8 percent,

■ CONTINUED ON PAGE 52



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Oil Industry Insurance Problems

By JAMES H. JOHNSON

Manager of Insurance, Cit-Con Oil Corporation, Lake Charles, La.

OIL COMPANIES and drilling contractors face some peculiar problems of insurance, as well as the ordinary insurance problems found in other forms of business. Some of these special problems have resulted from recent court decisions, such as the Texas decision that a drilling company was liable for damage when a well blew out and cratered.

This paper is from a talk before the North Texas Oil and Gas Association, Wichita Falls, Texas.

CURRENT conditions in the insurance markets as well as recent court decisions which have resulted in many interpretative changes of the law make the subject of insurance of greater importance to the oil industry than ever before. Those who have studied insurance trends as they affect operators and drilling contractors agree that the industry is faced with some very peculiar problems which will require effort and ingenuity to solve if the industry, insurance-wise, is to protect itself adequately against ever-changing hazards.

The nature and amounts of protection required in the oil industry vary with the risks involved in operations. The operator who produces, manufactures and markets oil has need for many kinds of insurance not necessary where only drilling operations are to be carried on.

At the same time the industry must recognize that insurance companies have their own troubles and that in order to keep from becoming insolvent or be compelled to discontinue writing insurance they must keep within the limit of their assets and that the amount of new business they can handle is controlled by such assets. There are very few insurance companies today who are not offered more business than they can write and still stay within the regulations imposed by the insurance departments in their respective states.

Such limitations constitute a serious problem for insurance companies because, if they exceed their allowable writing and the Insurance Commissioner refused to permit them to continue in business, the general public would not understand such action and would probably get the impression that the insurance company, or companies, were insolvent. This would not necessarily be true but it would have the same effect on the public.

One difficulty in insuring oil companies is the large concentration of property values and the exposure of the companies to serious liability claims.

The property insurance has been well taken care of by the large fire insurance companies in forming pools to spread the loss in case of conflagration. The liability protection has no such group where the insurance companies can spread their liability so as to take care of large claims without injury to their financial structure.

In view of prevailing conditions in the insurance field it is absolutely necessary that the oil industry either establish a plan of self-insurance and comply with all state regulations, or purchase primary insurance from an underwriter who is admitted to transact insurance business in the state where the insured is operating.

Self-Insurance

If an individual or company does not feel it can obtain rates comparable with loss experience, he or it may choose to go self-insured. This, however, is not recommended until considerable study of the problems involved and an exhaustive search in the insurance markets for the protection desired have been made. One thing self-insuring will do—it will make the company very claim-minded and safety conscious.

An insurance company can handle claims at less cost because it maintains an adjustment service to handle claims for all assureds. In compensation cases as well as liability cases, a claimant will accept what an industrial board or court considers a fair award, whereas he may expect to receive more from a self-insured company due to years of service or his connection with that company.

To handle properly the coverage for an operator or drilling contractor it is necessary that a careful study be made of all operations involved in order to determine the hazards which may be present and to decide which shall be insured.

It will be necessary that the operator assume some of his liability, since insuring all possible sources of loss would be a heavy expense to his business.

Major hazards which an operator or drilling contractor will most likely want to insure are:

- Fire and extended coverage
- Workmen's compensation
- General liability and property damage
- Automobile liability and property damage
- Various types of aircraft liability
- Boiler explosion (if operating boilers)

There are many types of insurance which the operator may find advisable to purchase but which will not be necessary for the drilling contractor, such as:

- Fidelity bonds
- Oil and gas lease bonds
- Elevator liability, and
- Burglary and robbery

A careful operator will not encounter much difficulty in procuring compensation protection at low rates, but the increased awards being allowed by the industrial boards and the courts, as well as higher payrolls, make the cost of this type of protection greater each succeeding year, even though the state rating authorities do allow a credit for a good experience.

Compensation insurance is required by all states. The manner of handling varies from a compulsory state fund, as in Wyoming, to the option of self-insurance

or the purchase of insurance from an insurance carrier, as in Oklahoma which, incidentally, is the only state where the compensation law does not cover death, it being handled as employers' liability under the Oklahoma Compensation policy.

Under the subject of Fire Insurance, explosion and windstorm are included and incorporated under the same insurance policy.

All operators and drilling contractors are faced with a possible loss due to the above hazards. The necessity for coverage will depend a great deal on whether or not the property insured is so congested as to cause a loss which will be in an amount greater than the operator is willing to assume, in which case some of the property can be self-insured. It is a general practice, however, where this insurance is carried, that all of the property owned by the operator be included in his policy, or definitely excluded, so there can be no question as to the intent of the policy.

For the operator who has ample fire-fighting equipment for the protection of his property and who operates carefully it is not difficult to obtain coverage.

Rates Vary

The drilling contractor is faced with a different problem since premium rates on drilling rigs and equipment vary with the location where drilling is being done. The type policy usually used in writing this insurance is inland marine and most operators require that it include the waiver of subrogation. This provision prevents the insurance company from paying the loss to the drilling contractor and then recovering from the operator.

It has been the custom of a great many drilling contractors to insure only their rigs during drilling operations and, in some instances, to insure only when operators require this protection. It would be wiser if all drilling rigs were covered whether being used or stacked since, in the final analysis, rates would be reduced with the greater volume of premium to the extent that it would be profitable to the drilling contractor.

In Texas, General Public Liability and Property Damage insurance is the type that concerns operators and drilling contractors at the present time. A few years ago property damage feature was not considered important by most drilling contractors. The writer recalls when it was almost impossible to get an operator or drilling contractor to agree that public property damage was necessary since they felt there was little liability in any loss which they could not pay.

This situation has changed, especially in Texas, where there have been some very serious property damage losses. The case of Elliff vs. Texon Drilling Company is an example which emphasizes the change that has taken place in this way of thinking. In that case the Texas Supreme Court held that plaintiff was entitled to recover for damage resulting from a well getting out of control, blowing out and cratering. This decision has caused apprehension in insurance circles over including any property damage below the surface of the ground.

As a result of the filing on the part of the insurance companies for increased rates covering underground damage the oil industry is faced with having to pay a substantial increase in rate if the protection is to be afforded. It appears that a great many of the insurance companies who have written, and are now writing the coverage of underground property damage, have limited the amount they will take on any one well to $25,000. There are a few who will write as much as $50,000, and probably not more than three or four who will write $100,000. This does not provide ample protection for the average drilling contractor since it is possible to exceed more than $1 million in any one loss and the drilling contractor is not prepared, financially, to pay any such judgment.

The only way in which additional coverage can be had at the present time is through some of the excess markets—principally Lloyds of London. The American excess markets are not including underground damage at the present time. Since the American excess markets are willing to write excess coverage to include offshore drilling, the writer sees no reason why they should not be willing to include underground damage.

It would seem where there is a hazard which could result in such a substantial loss, the casualty companies could combine for the purpose of accepting higher limits.

If the decision in the Elliff case mentioned above is followed, the time may come when drilling in the high pressure areas may have to be discontinued because the contractor will not be willing to assume the risk for underground damage.

There are many vehicles such as automobiles, tractors and trucks, in connection with all oil industry risks, which fall under the regular automobile classification. Fleet coverage can be worked out through the proper markets to produce ample protection at rates which are not excessive. The primary limits on automobile fleets do not necessarily have to be high since it is generally more economical to insure at moderately low primary limits, and provide excess coverage to protect against the serious claim.

Another reason for writing at low primary limits and purchasing excess protection is because in some states the primary policy can be subpoenaed into court and may have an effect upon the jury in making the award.

Excess protection can well be applied to all the types of protection purchased because a high limit of excess coverage is purchased at a lower rate than primary coverage and the assured may feel well taken care of in the event of catastrophe.

Choosing the Agent

In order to obtain the protection needed by the operators and drilling contractors through agents or brokers it is imperative to select an agent or broker who is capable of surveying a risk and who has full knowledge of the insurance company's methods of rating and writing various types of coverage. The agent or broker should know, and have access to, the various markets from which to procure the type of insurance sought.

Nothing is gained by an assured in permitting his insurance to be split up and written by a number of agents and the writer recommends that full responsibility be placed on one.

Insurance protection is no better than the agent's or broker's knowledge of his client's requirements as well as his knowledge of the financial responsibility of the carriers with whom he places the insurance and his access to the best markets. Therefore, it behooves the operator and drilling contractor to select his agent or broker carefully in order to obtain the maximum service in meeting his insurance requirements.

About the Author

JAMES H. JOHNSON graduated from Kansas State College in the School of Electrical Engineering and entered the insurance business in 1915 as chief engineer for the Fire Insurance Companies' Rating Bureau at Topeka, Kansas. After working in Chicago and New York he joined Marland Oil Company in 1926 as insurance engineer and when that company merged with Continental Oil Company he became insurance manager. He held that position until his retirement March 1, 1949. He is now insurance manager for Cit-Con Oil Corporation at Lake Charles, La.

Observations on Oil and Gas Leases

By VERNE E. ROBINSON
Los Angeles, California

LESSEES have been forced to pay millions of dollars as a result of the use of improper words or the omission of proper words in leases, or as a result of implied obligations binding them.

One operator had to pay the landowner $\frac{1}{2}$ million because the court held that he had not complied with the implied obligation of a lease to protect the property from drainage, although he had drilled the number of wells specified in the lease to be drilled.[1]

Another operator was forced to pay $100,000 because he had used an incorrect method in the sampling of the wet oil.[2]

Rarely does the landowner have an adequate understanding of the meaning of the complex terms of an oil lease, and most operators or lessees (excluding, of course, their lawyers or legal departments), are so involved in the intricate problem of exploration and production that they are not too much concerned with the exact words used in a lease. The outcome of litigation frequently turns on the use or meaning of particular words.

In this article no attempt is made to comment on all of the provisions of an oil lease, or even to treat fully the matters herein mentioned. Primary purpose of the article is to make a few observations as to the general effect of some of the provisions of oil and gas leases, particularly as used in those states where an attempt is made to spell out in detail the respective rights and obligations of the lessees and lessors.

In the interests of brevity, entirely different points are set forth in each of the succeeding paragraphs, although an effort has been made to group relative ideas under the appropriate titles.

It has been held that a dollar consideration was sufficient for an oil lease on unproven land.[3]

If there is no consideration for the execution of a lease and the lessee has the unqualified right to quitclaim without the payment of any consideration, the lease is probably a mere revocable option, at least up until the time that the lessee does something in reliance upon the terms of the lease.[4]

If a bonus for a lease is made payable out of a certain percentage of the production from another property, the lessee cannot be relieved of liability to pay the bonus by quitclaiming the property for which the bonus was agreed to be given.[5]

The necessity for uniform bonus payments to community lessors for the execution of a community lease is a matter which has bothered the legal profession for some time. The practice seems to be generally to make the payments uniform but the necessity of so doing seems questionable.

OIL OPERATORS generally have so many problems of exploration and production that they are not too much concerned with the exact words used in leases. However, operators have been forced to pay millions of dollars because of use of improper words or omission of proper words in leases or as a result of implied obligations binding them. This article offers general observations as to the general effect of some of the provisions of oil and gas leases, especially as used in states where respective rights and obligations of operator and landowner are spelled out in detail.

There is a great variance in the rights given to lessees to use the surface of leased properties. The rights vary from the privilege of using the surface of the property only for the drilling of wells for production from the property, to the exclusive right to use the surface for any purpose except the use reserved to the lessors. If a lease gives a lessee the exclusive right to the use of the property and reserves only limited uses to the lessor, the lessee may use the property for any purpose other than those reserved, including the right to use the surface for whipstocking of wells to produce from adjoining property.[6]

The right of the lessee to utilize the surface of the property for the building of gasoline extraction plants or refineries to treat gas or oil produced from other properties is frequently contained in the granting clause, but if such right is not given expressly, the lessee has no right to so use the leased property.

A lease reserving a strip of ground for road purposes does not reserve the mineral rights under the strip.[7]

Some companies are now including riders to their ordinary printed form of lease, allowing the unitization of the leased property with other property. Leased land, of course, cannot be unitized without the consent of the lessors.

Lease Terms

If an oil and gas lease runs for a definite period of years and so long thereafter as oil, gas or other hydrocarbon substances are produced from the leased property it is, in effect, real estate, in some states.[8]

A lease which runs only for a definite period of years is personal property. If a lease is real property, stamp taxes are

required upon its execution and upon any assignments thereof, and the laws applicable to transfers of real property govern its execution and assignment. If the term of a lease is for a specified number of years and so long thereafter as oil or gas is produced in paying quantities, production in paying quantities at the end of the specified number of years is a condition precedent to the continuation of the lease.[9]

If, however, in accordance with the provisions of a price clause, production is shut in at the end of the specified term, the lease may nevertheless continue.[10]

No notice of termination or default is necessary in case a lease expires by its terms.

Distinctions have been made in the interpretation of the clause "producing oil in paying quantities" in the drilling portion of the lease and that used in the habendum or term clause of the lease. Where there is an obligation upon the lessee to operate as long as oil is produced in paying quantities, the assignee of the lessee who assumed the obligations of the lessee and took the lease subject to heavy overriding royalties was not allowed to deduct the overriding royalties in determining whether or not the property produced in paying quantities.[11]

If the lessee grants royalties in the oil and gas to be produced under the terms of a specific lease, a question arises as to whether or not the holder of the overriding royalties is entitled to participate in production obtained under a renewal, or even an extension, of the lease. The words used in the granting of royalties become important in such an instance.

Drilling Clauses

There is a vast difference in the rights under an "unless" lease and under an "or" lease.[12] Under an "or" lease, if the lessee quitclaims his rights under the lease after rentals have accrued, he is liable for the accrued rentals,[13] while under an "unless" lease which provides for the payment of rentals, no such obligation exists because the lease terminates by its terms unless certain things are done.

Under a lease which requires the commencement of the drilling of an additional well within a specified time after the discovery of oil in paying quantities, the lessee is allowed a reasonable length of time in which to determine whether or not a well is producing oil in paying quantities.[14]

Where a lease provided that a second well should be commenced within three months after the first well was completed, it was held that the first well had been completed where drilling operations had been suspended and pumping equipment installed. Although the well sanded up every few days and had to be worked on, it had produced only 500 barrels of oil per month for each of a few months.

The California Public Resources Code, Section 3217, provides that a well is completed for the purposes of that Code 30 days after it has commenced to produce oil unless the drilling operations are resumed before the end of the 30-day period.[15]

Going into an old well, abandoning a portion of the hole, and whipstocking and drilling to and producing from the same strata from which the old well had been producing is not the drilling of a new or additional well.[16]

The courts have read into oil and gas leases many implied covenants. Covenants will be implied to use reasonable diligence in the exploration and discovery of oil and thereafter in the development of the lease and the protection from drainage through wells on adjoining lands.[17]

Even though drilling requirements as to the number of wells have been fulfilled, the lessee is still obligated to drill sufficient additional wells to protect the property from drainage. This is true even though the additional well or wells must be drilled to new horizons.[18]

A lessee has been held liable for drainage where it operated adjoining property, even though the drilling requirements as to the number of wells had been fulfilled, and although the offset wells could not be operated at a profit.[17]

Most of the printed forms of leases now used in California contain a clause designed to obviate the implied obligations. A typical clause in that regard is as follows:

> "No implied covenant shall be read into this lease requiring the lessee to continue drilling on said land or fixing the measure of diligence therefor."

The effect of such a clause is commented upon in a case wherein the court held that in view of such a clause it was necessary to look only to the express terms of the contract to determine the rights of the parties.[19] The inclusion in a lease of a clause which obviates the implied obligations binding on the lessee is of great value to him.

In the absence of such a clause, the operator of a lease in a field where multiple zones are developed would undoubtedly be required to drill a sufficient number of wells to each zone to protect fully the property from drainage, even though the maximum number of wells specified in the lease have been drilled.

Where a lease provides that a well drilled within a certain number of feet from its exterior boundaries must be offset, a question may arise as to whether or not the surface location or the bottom of the hole is to be used in determining whether or not the well should be offset.

Even though a company was not negligent in the drilling of a well but proceeded in accordance with good oil field practice and used every known safety device to protect persons and property from injury or damage, it was nevertheless held liable for damages resulting from a "blowout."[20]

Rules on Royalties

The lessee was held liable for underpayment of royalties where he used a method of sampling not general in the field, where the method used by the lessee gave an incorrect result.[21]

Royalty oil means crude oil, less free water, and not cleaned oil.[22]

If a lessee is bound to sell oil at the highest price, he must clean the oil at his own expense.[23]

Gaining popularity are clauses to the effect that if a lessor does not object to statements rendered by the lessee within a particular length of time, the lessor is foreclosed so to do.

An interesting rule has been developed in at least one jurisdiction in regard to community oil and gas leases. Each lessor in a community oil and gas lease, upon the execution of the lease, is deemed to have acquired an interest in the land of his co-lessors, which is in the nature of real estate, and a conveyance of the land of a particular lessor

About the Author

VERNE E. ROBINSON has specialized in oil law and has had wide experience in the law applicable to oil and gas leases and marketing of oil. He was born in LaCrosse, Wis.; served in the Marines in World War I; and was admitted to the Bar of the State of California in 1917, and to the California Bar in 1923.

does not carry with it that lessor's royalty interest in the lands of his co-lessors unless the conveyance so provides.[24]

The owner of a parcel of land under a community lease whose land has been quitclaimed by the lessee is still entitled to participate in royalties under the community lease even though he has subsequently leased the quitclaimed land to others and is receiving royalties therefrom.[25]

If, however, a community lessor is in default under the terms of his lease, i.e., loses title to his property by virtue of the foreclosure of a prior lien, he also loses his right to participate in the oil produced from the lands of his co-lessors.[26]

If an overriding royalty owner is entitled to participate in a well drilled upon a particular parcel of land, a fine question arises as to whether or not he is entitled to participate in a well which has its surface location upon the particular parcel of land in question but is whipstocked to and produces from property belonging to the lessee adjoining the particular parcel in which the royalty holder is interested. A well, the surface location of which was in the city of Los Angeles and the producing horizon of which was in the city of Long Beach, was held to be producing oil in the city of Las Angeles.[27]

In California there is no legal distinction between a royalty by virtue of which the royalty owner is entitled to a certain percentage of the production and a certain percentage of the proceeds of production.[28]

If a lessee sells royalty interests, there is an implied obligation that he will use the funds obtained therefor for the purposes of obtaining production.[29]

Although overriding or participating royalties are limited interests in real property, they terminate upon the quitclaiming, or termination, of the lease.[30]

A grant of 2½ percent of the oil, gas and other hydrocarbon substances in and under and that may be produced from an undivided one-half interest in a certain specifically described property conveys only a 1¼ percent of 100 percent of the production obtained from the whole of the property.[31]

A person who owned 8⅓ percent of the mineral rights in a piece of property who did not sign a lease as a lessor but who ratified a lease made on the whole property, which lease was on the basis of a 1/6 royalty, was entitled to 8⅓ percent of the 100 percent of the production, or one-half of the landowner's royalty.[32]

A deed to the mineral fee carries with it a right of entry without specific words to that effect. Although generally if the owner of a fractional part of the minerals does not join in the execution of the lease, his interest is subject to his proportionate cost of development, etc., if an intent to the contrary is shown he is entitled to his fractional part of the production without the deduction.[33]

Some community oil and gas leases provide that each owner of the property upon which production is obtained shall be entitled to one-half or some other percentage of the royalty payable from production obtained from his property, the remaining portion of the royalty being divided among all of the lessors, including the one from whose property the production is obtained, in the proportion that the area of each owner's land bears to the total acreage leased.

Any conveyance of a royalty interest in California is deemed to be a security and requires a permit from the Commissioner of Corporations before the same may be issued.

Assignments or Subletting

Prohibitions against assignments or subletting are not violated by certain types of drilling and operating contracts.[34]

Restrictions in a lease prohibiting assignment are personal to the landowner and do not run with the land; that is, if the landowner sells his land subject to a lease which prohibits assignment, the prohibition cannot be enforced by the new landowner.[35]

A party who is benefited by a clause against assignment in a lease may waive his rights thereunder by dealing with the assignee in regard to the lease with knowledge of the assignment.[36]

An assignee of a lessee who has not assumed the obligations of the lease is nevertheless bound by all of the covenants in the lease that run with the land, i.e., agreements that are generally for the benefit of the leased property itself. Under this theory, an assignee of a lessee who was in possession at the termination of the lease, but who did not assume the obligations of the lease, was held liable to fill sumps.[37]

Also upon this theory an assignee who did not assume the obligations of a lease which contained a covenant that the lessee would keep the property free of liens was held liable for a lien which attached subsequent to his taking title to the lease, even though the obligation which gave rise to the lien was created prior to the time that the assignee took the lease.[38]

Unless there is a provision in the lease to the contrary, the assignee of a portion of the leased land may be in default or have his lease jeopardized in the event of a default on any portion of the lease owned by others. If an assignment of a lease is prohibited without the consent of the lessor, a consent once given obviates the necessity of consent for future assignment unless there is a provision in the lease or consent to the assignment to the contrary.

Defaults and Forfeitures

Unless a lease otherwise provides, a notice of default must be signed by each lessor.[39]

Where a lessee starts drilling in good faith after notice of default, a new notice is required for a subsequent default on the part of the lessee.[40]

Although notice of default is required in order to work a forfeiture, no notice is required to be given by the landowner to terminate the lease if the lease is abandoned by the lessee.[41]

In case the owner gives an unjustifiable or wrongful notice of default and termination, the lessee may either sue for damages for the wrongful repudiation of the lease, or he may disregard the notice and sue for damages.[42]

Acceptance of rents by a landlord after breach of the conditions of an oil lease, with full knowledge of all the facts, is a waiver of the breach and precludes the landlord from declaring a forfeiture by reason of the breach. However, where there is a continuing covenant to carry on drilling operations with due diligence until a certain number of additional wells have been completed, the acceptance of royalties does not constitute a waiver of future breaches of the lease.[43]

If a lease has no provision for forfeiture, it can still be forfeited for lack of drilling.[44]

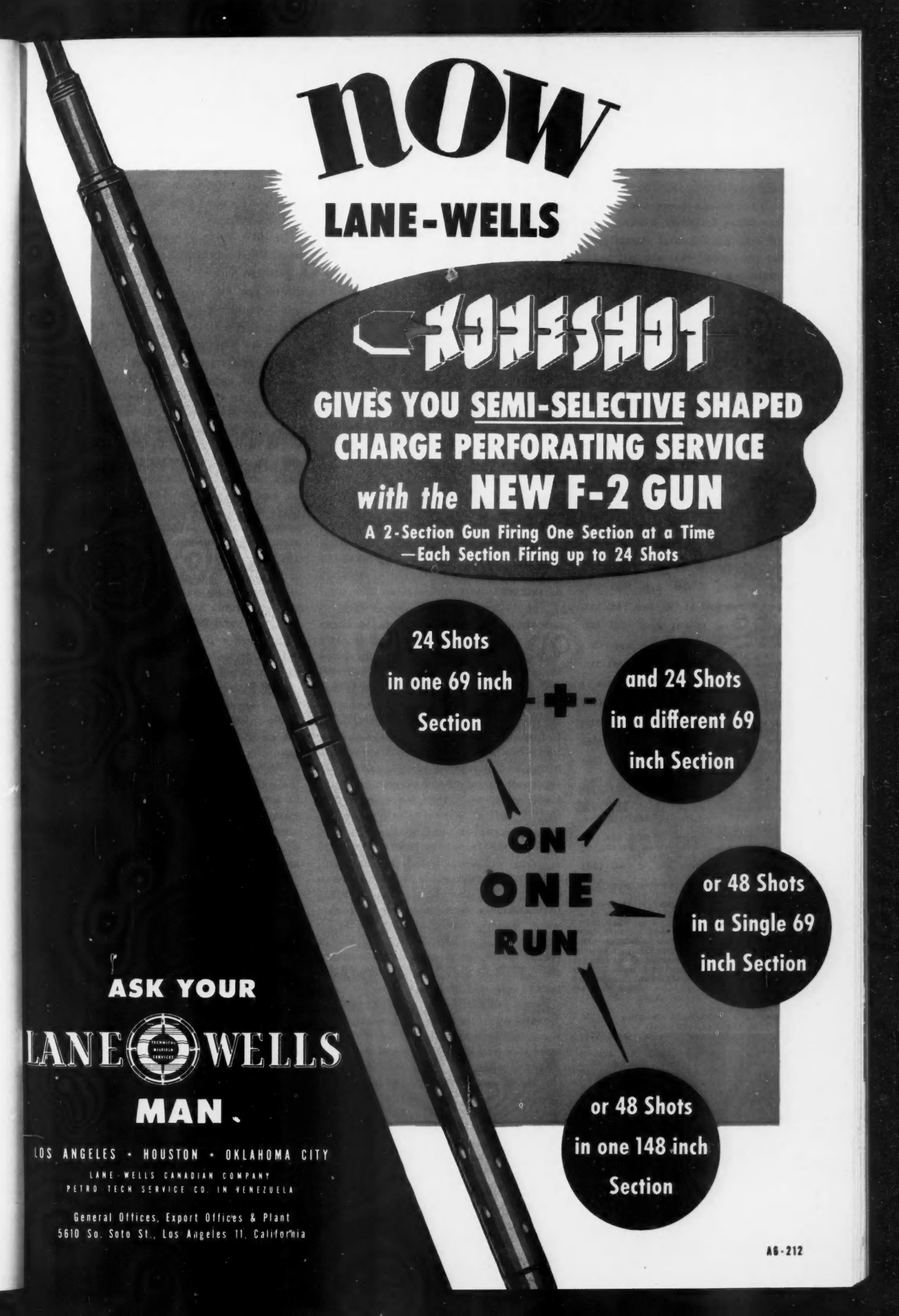
A relief from forfeiture will not be granted where there is a wilful default on the part of the lessee.[45]

In an action against a corporation and its officers, for fraud arising out of an oil and gas lease, the individual defendants were held liable for damages sustained although they were not parties to the contract, where they were in control of management of the wells in question and participated in a plan to deceive the lessors.[46]

A clause to the effect that the waiver of the breach of any of the provisions of a lease shall not be construed as a waiver of a continuing breach of such provision, or the waiver of the breach of any other provision of the lease, has been used to the material advantage of a lessor.

It must be distinctly borne in mind that the observations herein made are based on the facts and circumstances involved in the respective cases referred to herein.

In the past few years most oil and gas leases have been made upon printed forms prepared generally for the benefit of lessees. There seems to be a peculiar twist in the human mind that allows a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person to sign a printed document much more readily than he will sign a typewritten one. It is apparent that a lease which might be appropriate for land having little present or potential surface value, might well be inappropriate for land which has a high present or potential surface value. Likewise, a lease upon proven or semi-proven land should contain many provisions that are not ordinarily contained in a lease upon unproven property.

REFERENCES

[1] Hartman v. Associated, 10 Cal. (2d) 232; 73 Pac. (2d) 1163.
[2] Meyers v. Texas Company, 6 Cal. (2d) 610; 59 Pac. (2d) 132.
[3] Guffey v. Smith, 237 U.S. 101; 35 Supreme Ct. 526; 59 L.Ed. 856.
[4] Scheel v. Harr, 27 Cal. App. (2d) 345; 80 Pac. (2d) 1035; Jolliffe v. Steele, 9 Cal. App. 212; 98 Pac. 544.
[5] Elsinore Oil Company v. Signal, 3 Cal. App. (2d) 570; 40 Pac. (2d) 523.
[6] Taylor v. Odell, 50 Cal. App. (2d) 115; 122 Pac. (2d) 919.
[7] Lewis v. Standard Oil Company, 88 Fed. (2d) 512.
[8] Callahan v. Martin, 3 Cal. (2d) 110; 43 Pac. (2d) 788; 101 ALR 871.
[9] Moon v. Marker, 26 Cal. App. (2d) 33; 78 Pac. (2d) 460.
[10] Macco v. Fickert, 76 Cal. App. (2d) 295; 172 Pac. (2d) 951.
[11] Transport Oil v. Exeter Oil, 84 Cal. App. (2d) 616; 191 Pac. (2d) 129; Summers Oil & Gas (perm. ed.) Paragraphs 287, 306.
[12] 67 ALR 223.
[13] Wilcox v. West, 45 Cal. App. (2d) 267; 114 Pac. (2d) 39.
[14] Welport v. Fairfield, 51 Cal. App. (2d) 533; 125 Pac. (2d) 97.
[15] Siemon v. Lyon, 51 Cal. App. (2d) 350; 124 Pac. (2d) 893.
[16] Moore v. Bartholomae, 69 Cal. App. (2d) 474; 159 Pac. (2d) 436.
[17] Hartman v. Associated, 10 Cal. (2d) 232; 73 Pac. (2d) 1163.
[18] Jones v. Interstate, 115 Cal. App. 302; 1 Pac. (2d) 1051.
[19] Swigert v. Stafford, 85 Cal. App. (2d) 469; 193 Pac. (2d) 108.
[20] Green v. General Petroleum, 205 Cal. 328; 270 Pac. 952.
[21] Meyers v. Texas Company, 6 Cal. (2d) 610; 59 Pac. (2d) 132.
[22] Alamitos Land Co. v. Shell, 3 Cal. (2d) 396; 44 Pac. (2d) 573.
[23] Transport Oil v. Bush, 114 Cal. 152; 1 Pac. (2d) 1060.
[24] Tanner v. Title Ins. & Trust Co., 20 Cal. (2nd) 814; 129 Pac. (2d) 383.
[25] Tanner v. Olds, 29 Cal. (2d) 310; 173 Pac. (2d) 6; 167 ALR 1219.
[26] Gillis v. Royalty Service, 91 ACA 402.
[27] City of Los Angeles v. Union Pacific, 53 Cal. App. (2d) 825; 128 Pac. (2d) 408.
[28] Schiffman v. Richfield Oil, 8 Cal. (2d) 211; 64 Pac. (2d) 1081.
[29] Differding v. Ballagh, 121 Cal. App. 1; 8 Pac. (2d) 201.
[30] La Laguna Ranch Company v. Dodge, 18 Cal. (2d) 132; 135 ALR 546; 114 Pac. (2d) 351.
[31] Mitchel v. Brown, 43 Cal. App. (2d) 217; 110 Pac. (2d) 456.
[32] Little v. Mountain View Dairies, 34 ACA 167.
[33] Dabney Johnson Oil Co. v. Walden, 4 Cal. (2d) 637; 52 Pac. (2d) 237.
[34] Higgins v. Exeter Oil Co., 45 Cal. App. (2d) 792; 115 Pac. (2d) 13.
[35] Taylor v. Odell, 50 Cal. App. (2d) 115; 122 Pac. (2d) 919.
[36] Trubowitch v. Riverbank Canning Co., 30 Cal. (2d) 335; 182 Pac. (2d) 182.
[37] Washburn v. Gilmore, 116 Cal. App. 370; 2 Pac. (2d) 506.
[38] Richardson v. Callahan, 213 Cal. 683; 3 Pac. (2d) 927.
[39] Jameson v. Chanslor, 176 Cal. 1; 167 Pac. 369.
[40] Smith v. Edleman, 214 Cal. 488; 6 Pac. (2d) 508; Alphonzo E. Bell Corp. v. Listle, 55 Cal. App. (2d) 300; 130 Pac. (2d) 251.
[41] Romero v. Brewer, 58 Cal. App. (2d) 759; 137 Pac. (2d) 872.
[42] Alphonzo E. Bell Corp. v. Listle, 74 Cal. App. (2d) 638; 169 Pac. (2d) 462.
[43] Beran v. Harris, 91 ACA 661.
[44] Hall v. Augur, 82 Cal. App. 594; 256 Pac. 232.
[45] El Rio Oil v. Chase, 93 ACA 8.
[46] Doyle v. Chief Oil Company, 64 Cal. App. (2d) 284; 184 Pac. (2d) 915.

Curbing Texas Gas Exports Is Unsound Proposal

■ CONTINUED FROM PAGE 44

while Texas held 95.7 trillion or 55.0 percent. Of the U. S. marketed production of 4444.7 billion cubic feet in 1947, they produced 1311.2 billion or 29.5 percent, compared with 1932.8 billion or 43.5 percent for Texas. Of the U. S. interstate transportation and exports of natural gas of 1326.9 billion cubic feet in 1947, the four states accounted for 567.9 billion or 42.8 percent, which was more than the 523.2 billion or 39.4 percent for Texas. It is noteworthy, too, that those neighboring states are nearer the Midwestern and Eastern markets than is Texas. With today's pipe line techniques, natural gas found practically anywhere in North America can be moved economically to major U. S. population centers. Along with the question of whether or not to export Texas gas, it is pertinent to consider whether or not Texas gas could retain or expand its out-of-state markets, in competition with gas from other states, if Texas gas should be overtaxed or burdened with restrictions upon its movement.

The theory that a large supply of cheap gas would attract new industries to Texas has been largely disproved. In the early 1930's, when gas was practically given away in the Panhandle, free fuel for several years was offered to any new industry that would locate in that area. To the amazement of many, this attraction failed to bring in new concerns. Fuel has been but a small factor in the location of factories and industrial plants, commonly representing only 2 to 5 percent of manufacturing costs. Other more important factors, such as source of raw materials, transportation and markets, are of greater importance in most cases. For chemical industries based on petroleum, Texas offers a favorable location close to raw materials, and the Gulf Coast offers the additional advantage of favorable water transportation, natural gas being in these cases an added attraction. But in some other industries, including iron and steel, Texas is not a highly favored location in spite of cheap fuel costs.

Some established manufacturers in Texas oppose exports of Texas gas on the grounds that they will in the future need this gas. However, these manufacturers doubtless have some fears that out-of-state demand for Texas gas will boost the prices they must pay for gas used in their plants.

While restriction of exports of Texas gas is advocated by various groups, such restriction would be of doubtful validity legally. The U. S. Supreme Court has ruled that under the Constitution, Oklahoma could not place an embargo on its products when that state attempted to restrain its gas exports. It is of interest to note that the concern evidenced by Oklahoma proved unwarranted. Natural gas is now being supplied to Oklahoma consumers in abundant quantities and is also being exported into Texas, Kansas and other states.

In 1919, West Virginia enacted a tax on the transportation of oil and gas by pipe lines. The U. S. Supreme Court declared this tax invalid for both oil and gas transported in interstate commerce, saying that a state tax to be valid "must not in its practical effect and operation burden interstate commerce."

Since it apparently would be invalid to place an embargo or special tax on interstate shipment of Texas gas, the idea has been proposed that exports might be discouraged by placing a special tax, such as a gathering tax of perhaps one cent per thousand cubic feet, on gas produced in Texas. Under one proposal that has been made, proceeds from a one cent gathering tax would be used to build county roads. However, any such special tax that might be levied in Texas on natural gas with the intent of discouraging exports actually would be paid largely by Texas home owners, industries, and businesses. For, as stated before, net exports of gas from Texas amount to only 15 percent of the total gas produced in the state, on the basis of 1947 figures. Furthermore, percentagewise a special one cent tax would bear heaviest on Texas consumers and lightest on gas exported. Texas consumers generally get gas available to distributors under old contracts where the price at the well is relatively low. A one cent tax added to a five cent wellhead price, for example, is a 20 percent tax. But a one cent tax on gas going for export, costing sometimes ten cents at the well, would amount to only 10 percent.

Taxes on gas produced in Texas are already relatively high. The farmer pays only ad valorem taxes, based on value of land, improvements, equipment, and livestock. The oil and gas industries pay not only similar ad valorem taxes on their producing properties, equipment, and other physical assets but also gross production taxes, amounting to 4⅛ percent of the value of oil produced and 5.2 percent of the value of gas produced. These gross production taxes themselves are special taxes, imposed for depletion of these natural resources, although not levied on some other natural resources, including iron ore, salt, magnesium, gypsum, fuller's earth, and ceramics clay.

If Texas had had in effect in 1948 the proposed new special tax of one cent per thousand cubic feet, the gross production tax on natural gas would have been 23.86 percent rather than 5.2 percent.

Baash-Ross News

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OUR 30th YEAR

. . . another new Baash-Ross development for greater safety—faster rig operations!

THE BAASH-ROSS SIGNAL WARNING CONTROL

- ***Protects Against Running Blocks Into Crown!***
- ***Unusually Simple and Positive in Operation!***
- ***Can Be Used On Any Type of Rig!***

After extensive development work with leading oil companies, Baash-Ross has perfected a new type of warning control to protect against the ever-present danger of running the traveling blocks into the crown . . . a warning control so simple, so positive in its operation that it sets entirely new standards of dependability in equipment of this type. And it can be used on any type of rig—steam, electric, spark plug or diesel!

Operating Principle is Simple, Positive

Basically, the Baash-Ross Signal Warning Control consists of a Limit Switch Assembly that is installed in the crown, and a Control Box and Horn unit that is installed near the driller's position at the rig floor. It is operated by simply connecting to the rig air supply and lighting circuit.

The Limit Switch is attached to the water table in the Crown, and the Weight Assembly suspended from the Limit Switch is placed around the deadline a little above the upper operating limit of the blocks. This Weight Assembly is split and hinged for easy installation on the dead line, and is equipped with hard rubber rollers to permit free movement up and down the line without wear or friction. Also note in the illustration that the suspension cable between the Switch and Weight Assembly incorporates a shock absorber spring to prevent damage to the Limit Switch unit.

As long as the blocks remain below the danger zone in the crown, the Weight Assembly suspended from the Limit Switch holds an electrical circuit closed. However, the instant the blocks move into the danger zone they lift the Weight Assembly, causing the Limit Switch to open and the Air Warning Horn near the driller's position to sound.

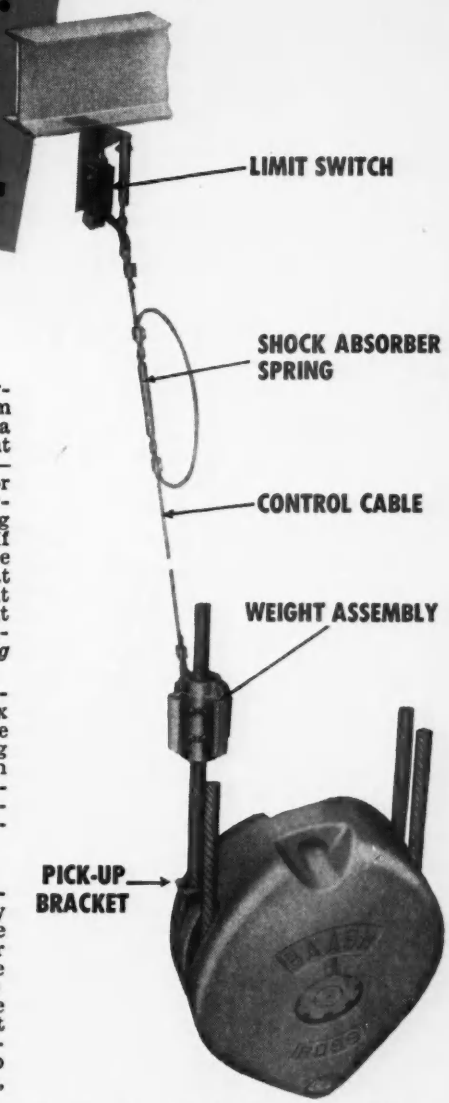
It is important to note that the Baash-Ross Warning Control is so arranged that the electric current flows through the circuit to *prevent* the warning horn from blowing—not to *cause* it to blow. This is a vital safety feature, for should the current be interrupted for any reason at all—either by lifting the Weight Assembly or by failure in the power supply, short circuits in the rig wiring, etc.—the warning horn will immediately start blowing. If the blocks are not in the danger zone then the crew knows immediately that the power supply should be checked. But as long as the air horn remains silent the Warning Control is in proper operating condition—*a valuable self-checking protective feature!*

Another valuable feature is that a bypass switch is provided in the Control Box to permit operating the blocks in the danger zone when necessary by pressing this switch in by hand. However, as soon as pressure is released, the switch *automatically* returns to its normal open position, preventing risk of someone forgetting to re-set the switch after use.

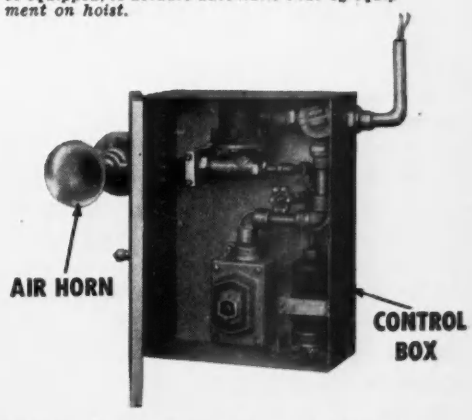
Automatic Control Equipment

The Baash-Ross Signal Warning Control can also be provided with accessory equipment to automatically disengage clutches, apply brakes and shut-off power to the draw works (depending upon the type of draw works and power unit used) whenever the blocks are raised into the danger zone. This accessory equipment can be readily varied to meet the operator's particular requirements—and also to meet the varying requirements of steam, electric and diesel-powered rigs.

The Baash-Ross Signal Warning Control is low in price, yet provides vital protection every drilling rig should have. After its simple installation it becomes a permanent part of the rig and is an investment that pays dividends over many years of trouble-free operation. *Write today for full details on this important safety development—or see your nearby Baash-Ross representative.*



View showing how Limit Switch Assembly is attached to water table in crown and supports Weight Assembly placed around dead line. When traveling block raises Weight Assembly, the Limit Switch is released to sound alarm and, if so equipped, to actuate automatic shut-off equipment on hoist.



Control Box and Warning Horn are placed at any convenient point near driller. Control Box is connected to Limit Switch Assembly through conduit for derrick lights.

CHECK THESE FEATURES!

POSITIVE OPERATION: Only the blocks raising the Weight Assembly, or failures in the power supply, will actuate the alarm. Even rough drilling and severe vibration will not impair its operation!

SELF-CHECKING: As long as the horn remains silent, system is in proper operating condition. Any power failures or short circuits are immediately indicated!

SIMPLE INSTALLATION: Wiring to Limit Switch in crown is permanently incorporated into rig lighting system. All other connections are at convenient floor level!

WIDE RANGE OF ACCESSORY EQUIPMENT: Permits automatic stopping, braking and clutching of draw works to meet individual requirements!

ANY TYPE OF RIG: Can be installed on steam, electric, spark plug or diesel rigs with equal efficiency!

LONG LIFE—NEGLIGIBLE MAINTENANCE: Initial cost is low, maintenance is negligible and no frequent adjustments are necessary!

Just one traveling block accident—even a minor one—can cost many times the price of a Baash-Ross Signal Warning Control. No drilling rig can afford to be without this vital protection!

West Virginia Faces Serious Stripper Problems

By J. E. BILLINGSLEY
Petroleum Research Engineer
West Virginia University

Part of the Blue Creek oil pool, Kanawha County, W. Va., discovered in 1911. The picture was taken in 1912.

THE peculiar characteristics of West Virginia oil, which are similar to the world-famed Pennsylvania crudes, make it imperative that every possible technique known to the reservoir engineer be employed to assure maximum production. Unfortunately, millions of barrels of oil in West Virginia fields cannot now be recovered economically under current secondary recovery methods, because many producers neglected in earlier years to apply the then known techniques to wells which were declining rapidly, due to dissipation of natural energy.

In the industry's over-all picture, the problem of maintaining current production in West Virginia fields is one that affects not only the operators in that area, but the national economy, which depends on the type of crude produced in those fields to meet exacting lubricating demands of industry. The vital part played by Pennsylvania-type crude oils was recently stressed in a brief presented before the Armed Service Petroleum Board.[1] The brief pointed out that this crude is essential to the nation's industrial and military requirements and declared that its importance is evidenced by the fact that the national average of lubricant recoveries from all crudes including Pennsylvania Grade is only 2.8 percent, while the average lubricant recovery from Pennsylvania Grade crude oil alone is above 23 percent.

There are approximately 30,000 oil and gas wells in West Virginia, of which about 90 percent may be classed as strippers. Of the total, about half are gas wells and half oil wells, the latter averaging about one-half barrel per day per well.

Peak oil production in the state occurred in 1900, when 16,196,000 barrels were produced and sold at an average price of $1.35 per barrel. After many changes in annual production, both increases and decreases, 1927 showed a production of 6,023,000 barrels. Since that time, there has been constant decline in annual production except for 1934, which had a slight increase over the preceding year. In 1945, for the first time since before 1900, annual production fell below the 3-million barrel figure, which has not been equaled since. In 1945 the total was 2,820,000 barrels and in 1948 it was approximately 2,690,000. In 1949 the state produced 2,795,000 barrels.

Gas production shows a somewhat better record because of the discovery of much deeper gas in quite large volume. If there had not been development of Oriskany sand gas production over the past ten or 12 years, the gas picture would have been as dismal as that of oil, or perhaps more so. The peak year for gas deliveries was 1917, when 309 billion cubic feet was produced. In 1923, gas production totaled 204 billion cubic feet, but declined to a low of 100 billion yearly in 1932 and 1933.

The trend was reversed a few years later, and greatly aided by the large volume of Oriskany sand gas and with war demand, production rose to a high of 248 billion cubic feet in 1942 and 1943. However, Oriskany sand production in these two years amounted to 125 billion in 1942 and to 93 billion in 1943. Consequently, the strippers could claim only 123 billion in 1942 and 155 billion in 1943. In 1948, gas production in the state totaled about 215 billion cubic feet, with the Oriskany sand being responsible for 25 billion and the shallow sands for 190 billion. This increase in shallow sand production came from the recently discovered fields in the extreme southern part of the state. Gas production for 1949 totaled 168 billion cubic feet.

West Virginia crude being of such high grade, and the gas produced being in the midst of a concentrated industrial area, operators enjoy a ready market and a fairly high sales rate. It is true also that total deliveries from many small oil or gas wells amount to rather large figures, but the fact remains that when the yield from a given well falls in value to a point below the cost of the well's operation, it must be abandoned unless there is some unusual circumstance that results in its being retained.

WEST VIRGINIA FIELDS produce premium grade crudes, highly desirable for making lubricating oils. However, wells are largely in the stripper class, abandonments are heavy, and permanent loss of much recoverable oil is threatened. To arrest abandonments and gain greater recovery of this desirable oil, operators must promptly take steps to reduce well operating costs and maintain production, through use of newer methods, equipment, and practices. Measures taken obviously must be held down in cost, but some degree of success should reward determined efforts to work out economical solutions to casing leaks and other problems involved.

Views of Granny's Creek pool, in Clay County, W. Va., discovered in 1925. Picture at left looks north from near the center of the field; at right, looking south. Both pictures illustrate the difficult topography which is common to West Virginia oil and gas producing areas.

Much as the situation may be deplored and despite the loss of developed reserves, which will in large part be forever lost, the economics of the case rule.

In 1948 a total of 1059 oil wells were abandoned in West Virginia, most of them without the benefit of secondary recovery operations. In addition, 811 gas wells and 112 combination oil and gas wells were abandoned during that year. This is a total of 1982 abandoned oil and gas wells and constitutes a record for any one year in the history of the industry in the state.

Since the end of the war, the abandonment rate has constantly increased. It was to combat this alarming rise and the decrease in production that the oil and gas industry, in cooperation with West Virginia University, caused the Petroleum Research Project to be inaugurated. It functions under the general supervision of the Engineering Experiment Station of the University, and the direct management of the School of Mines. It is financed by biannual appropriations made by the State Legislature, as a unit in the University's budget. In addition, the project is assisted and advised by an advisory committee composed of representatives of the oil and gas companies and the independent operators.

In considering the stripper well problem in the state, there are certain things involved which do not apply to most of the other oil and gas producing states. There was, a few years ago, and probably still is, one producing oil well which was drilled in 1863. Many still productive oil wells were drilled prior to 1890, but most extensive drilling occurred in the two decades from 1890 to 1910. Thus, many of these strippers range in age from 40 to 50 years or more, and immense oil, and later gas fields, covering wide acreages were developed long before such activity had occurred elsewhere, except in adjoining states.

Much of the material and equipment used was not in line with the modern version, and after enduring use and corrosion for many years, has been replaced, repaired and otherwise altered many times. Drilling procedures, the keeping of accurate well logs, the close recording of oil, gas and water zones, casing and packer settings, etc., were considered only incidental in the frantic search to develop new production. All of these things add to the difficulty of corrective operations, both in the matter of expense and the possibility of success.

In many oil fields, once of major importance, only a few scattered wells remain, and prior to 1931 when state plugging laws were enacted, the plugging operation, as to procedure, was left entirely in the hands of the individual operators. As a result, it is quite probable that many wells were improperly plugged and upper hole water was dumped on the producing formations.

Natural Water Drive

Curious to relate, it appears that in many instances, cavings sealed the formations, but there are also cases in which surviving wells appear to be affected by a natural water drive and show the presence of water foreign to the particular producing sand.

In the light of these conditions, it is remarkable that so much of both oil and gas have been recovered, that this recovery has covered so long a time span and that the greatly depleted productive horizons are still capable of additional yields. However, equipment, and especially casing, cannot last indefinitely in the presence of brine and acid waters, whose removal becomes increasingly expensive as the volume increases and the oil and gas yield declines. The inevitable result is abandonment.

The principal cause of well abandonments in West Virginia is attributable to water which either moves to the well bore through the producing formation as pressure declines or invades from above through casing leaks caused by acid corrosion or electrolysis, or possibly both. In either event, the pore space of the sand gradually becomes partially or completely filled with fluid other than oil or gas and production declines over a period of rising operation costs.

In connection with the abandonment of oil wells, one possible solution may be a more general use of secondary recovery methods, but there are various reasons why this is not always feasible in West Virginia. Many producing wells are widely scattered even in the same field due to abandonments in past years; in many areas the topography is difficult; depth to producing formations in many insances is too great to justify the cost of new drilling; many pay zones are very thin and remaining oil content is on the marginal side; and in many areas, initial production indicated porosity and permeability of a low order. Perhaps the greatest difficulty is the absence of much of the original data due to the fact that most of the drilling was completed before the importance of these data was realized, and this explains the fact that efforts to secure such information usually fail. It simply does not exist, except perhaps in someone's vague recollection, in so far as the earlier drilling is concerned. In more recent years, some formation coring has been done, but few operators are interested to any extent.

Historically, West Virginia operators

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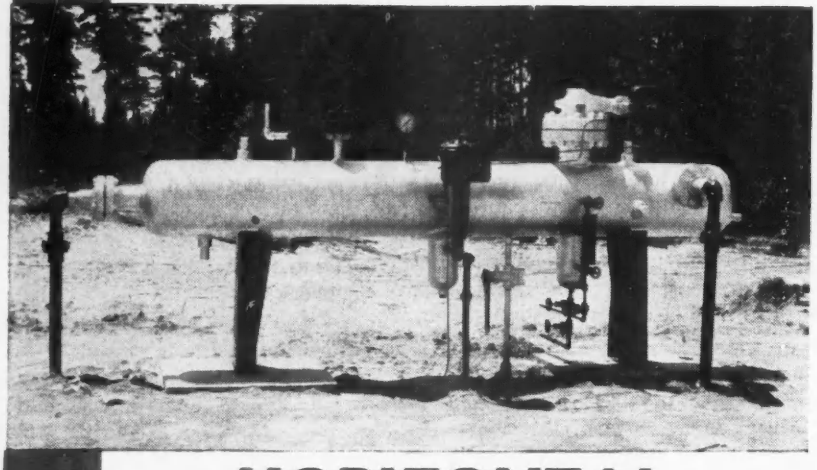

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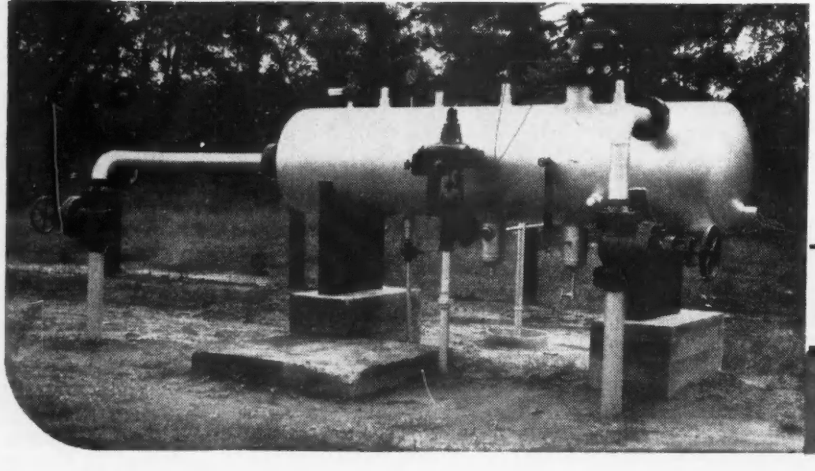

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ventured into secondary recovery at a quite early date and were, in fact, among the pioneers in this operation. First repressuring with air occurred in 1916; gas was first injected in 1922, and water in 1937. There have been a few failures and some outstanding successes, but in most instances a reasonably good recovery was realized. A recent survey showed 36 secondary recovery projects in operation. Of these, five are using water as the injection medium while the balance are using gas or air. No statutes affecting water repressuring exist at the present time, and such projects as are in operation function under permits granted by the State Department of Mines, with the approval of property owners who are or may be affected.

Operators should seriously consider steps designed to reduce well operating costs and maintain production by the adoption of newer methods of corrective operation than those so long in use. This will, of course, involve the use of new material, changes in equipment and practice, and a general re-shuffling of the cards in this particular deck. It will not be easy of accomplishment in view of earlier success, when deliveries were higher and operating costs were more readily absorbed. However, the stripper wells in West Virginia are rapidly approaching the point where something drastic must be done or they will fade from the picture, taking along an immense unrecoverable reserve, as indicated by our present knowledge.

An investigation of possibilities in this connection has been, and is now, the major activity of the research project. Obviously, the first item facing any approach to solution, in the economic factor. It is very evident that an oil well producing one-half barrel of oil daily, or a gas well delivering through the meter 20 to 30 thousand cubic feet daily, is no subject for an expensive correctional operation. Only the most inexpensive of agents and such as involve a minimum of labor and well time can be considered, and this fact has added greatly to other difficulties.

Experiments with this class of agents have been carried on over a considerable time. Promising results have been reached, but in most instances, actual field procedures have not been determined. It has been found over a two-year field experiment that in the Oriskany sand, at least, and by wetting agent treatment, gas deliveries may be prolonged and that operating costs may be lowered. Other incidental benefits, such as the partial elimination of pulsation at the well meters, have accrued, and the expense item is well within limits.

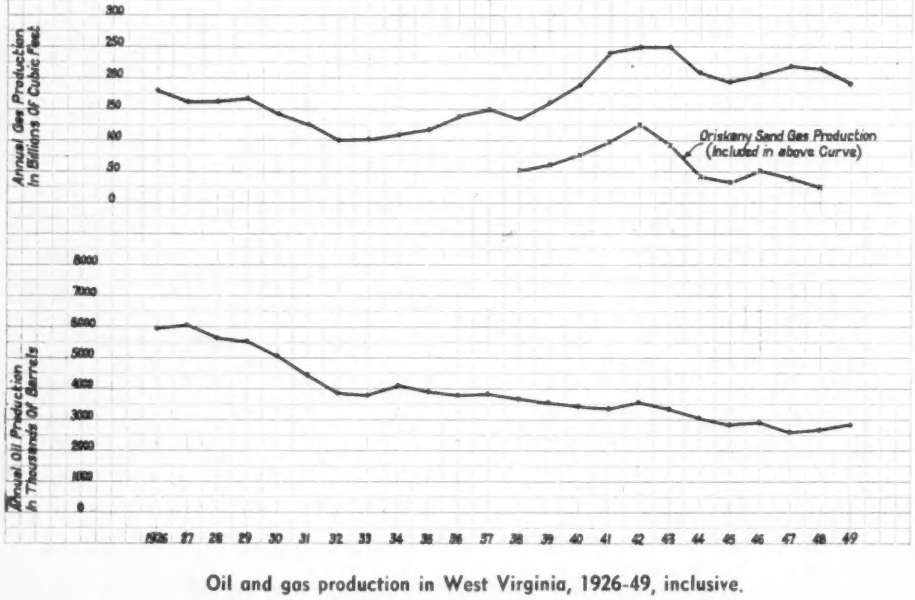
The matter of casing leaks in stripper wells is perhaps the outstanding difficulty which confronts the operators. Leaks caused by corrosion occur, in large part, below the coal seams, indicating that acid water from these seams is responsible and perhaps should have been sealed off by some penetrating agent at the time of drilling. Leaks caused by electrolysis may be anywhere over the length of the casing string. However caused, they are sooner or later fatal to the life of the well, and as noted above, the stripper does not rate a replacement string of casing.

The solution appears to be a squeeze job, using an agent which solidifies quickly and is impervious to, and insoluble in, the well liquids. Two such inexpensive agents are known in laboratory work, but one involves liquefaction at the point of leakage, while the other offers too short a setting time. It is entirely possible that answers may be found to both these problems.

Locating Leaks

In connection with the plugging of casing leaks and the introduction into the well bore at depth of agents for this purpose, it is obvious that the leak should be accurately located so that there will be no unnecessary loss of the plugging material and that it will be placed at the correct point. At least two separate efforts are under way at the moment to devise equipment that will accomplish this purpose for the stripper wells.

The above are only some of the difficulties that are faced daily by the owners and operators of stripper wells in West Virginia, but there are many others and their intensity increases constantly. If the 1948 rate of well abandonments continues, then the stripper problem will be automatically solved. However, there is reason to believe that, by careful and persistent effort on the part of both operators and investigators, these problems can be overcome and the life of these fields which produce a premium type crude so essential to the nation's economic life can be prolonged for many years.


Annual Gas Production In Billions Of Cubic Feet
Oriskany Sand Gas Production (Included in above Curve)
Annual Oil Production In Thousands Of Barrels
1926 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49

Oil and gas production in West Virginia, 1926-49, inclusive.

About the Author

J. E. BILLINGSLEY has acted in a consulting capacity in most of the oil and gas producing states east of the Rocky Mountains, but the major part of his experience has been in the Appalachian Province. His summary of the situation in West Virginia is the result of much study in his capacity as petroleum research engineer for West Virginia University, with which he has been associated since 1945. Prior to joining the university he was with West Virginia Gas Corporation.

REFERENCE

[1] J. P. Jones, Director of Production, Pennsylvania Grade Crude Oil Association.

Reef Surveying with Radioactivity

By R. A. STOTHART
Radioactive Surveys Company

EXTENSION of the application of the recording of radioactive emanations to the delineation of buried reef structures, such as characterize production in Scurry County, West Central Texas, for instance, has widened the usefulness of this means of oil-finding and now makes it a most important aid in tracing out wildcat areas for further testing with the drill.

Although oil itself is not radioactive, a radioactive anomaly is necessary to the presence of an oil field. The shales lying above the oil producing zones are the source of the emanations which, picked up by the sensitive instruments and amplified many times, energize the pen of the recording instrument and make the graphs which sharply indicate the limitations of the productive area as the surveying traverse is made.

Automatic recording of the surface emanations, developed after several years' experimentation, has been perfected to the point where the human element cannot affect the actual plotting of the data. Tubes and special equipment developed and used during the war have been modified and adapted to this highly specialized application in radioactive surveys. Ability to pick up and record the emanations has been greatly increased within the past year.

The usefulness of the radioactive survey is evident from the record of one crew during 1948. Out of seven radioactive anomalies or highs which were mapped and later drilled, four opened new fields, and one of the others had shows but not commercial production.

The delineation of faults and stratigraphic traps,[3] has now been extended to the mapping of faults, and the determination of probable production along that feature is relatively simple. Once a fault is known geologically, it is necessary only to cross the fault with traverse at right angles at frequent intervals, and to compare the change in radioactive emanations at the various traverses. The same technique is applicable and has been used successfully in locating the extension of faulting where earlier indications, geophysical work, and the drill had indicated the end of the producing area.[2] Closure against faulting can also be determined through the close spacing of stations and analyzing of the results shown on the record.

Apart from the influence of cosmic storms, sun-spots and other disturbances, the radioactive emanations check closely on re-runs. This is evident from Figure 1, which shows a survey across the Round Top field, Fisher County, Texas. The profile was started at the site of General Crude Oil Company's dry hole to the north of production, and was carried at random intervals across the field and until the radioactive values again dropped from the productive field-station highs to the low recorded at the dry hole. The increase in radioactive values above production was on the order of 100 percent as compared to values recorded over dry territory. Numerous other reefs were surveyed with like results.

Another traverse, across the Oklahoma City field, at intervals of one-quarter mile, or 1320 feet, sharply delineates the fault which limits production. The graphs, showing a continuous record across the dry territory on either side and across production, are not continuous recordings of the changing conditions as the instrument is carried across the terrain. Each station is selected, and the instrument placed on the ground to pick up emanations at that point. After a warmup period, the recordings begin, with the pen oscillating slowly across the moving roll of graph paper. These oscillations, graphically recorded, are shown to have a maximum value far above the record obtained before productive areas were reached. Averaging the pen motion, the high at the fault is found to be several times the average reading on unproductive terrain.

Following completion of recording at one station—a matter of about 15 minutes in most instances—the detector is placed in its special support in the car, and is moved the specified distance before being again taken out and placed on the ground to pick up emanations. During the period while the instrument is being moved, the recording unit is left active—kept warmed up, as it were—and thus the apparent lows are obtained between the groups of peaks which show for production. These peaks, in Figure 2, reduce in height or amplitude toward the observer's left, and thus indicate a reduction in probable productive value of the area in that direction. This indication is borne out by the last station reproduced in the figure, where the readings are very close to those obtained at stations across production and on the downthrow side of the fault.

RECORDING OF RADIOACTIVE emanations has been extended successfully to delineation of buried reef structures, which now are drawing much attention as good potential sources of oil. Shales overlying oil zones yield radioactive emanations which are picked up, amplified, and recorded at the surface, indicating limitations of the oil-productive area. Usefulness of the radioactive survey is evidenced by the record of one crew during 1948. Out of seven radioactive anomalies mapped and later drilled, four opened new fields and on had oil shows.

Survey Technique

As a reconnaissance method, the measurement and recording of radioactive emanations is comparatively fast, and does no damage to property. It may be carried out along roads as a preliminary, and then the car carrying the recorder can be driven into open areas where the preliminary data indicate the advisability of closer checking on the subsurface conditions. The recorder,

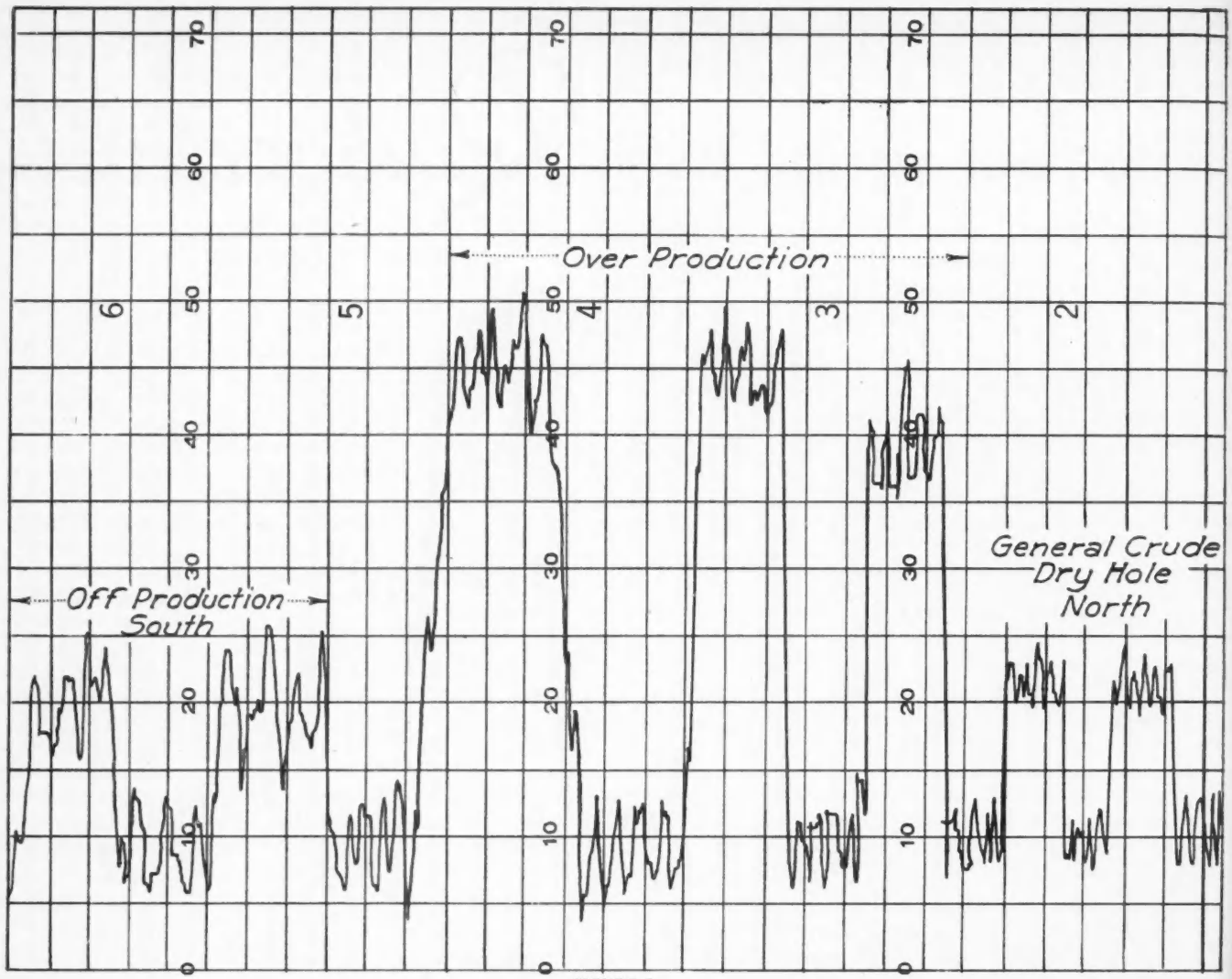


FIGURE 1

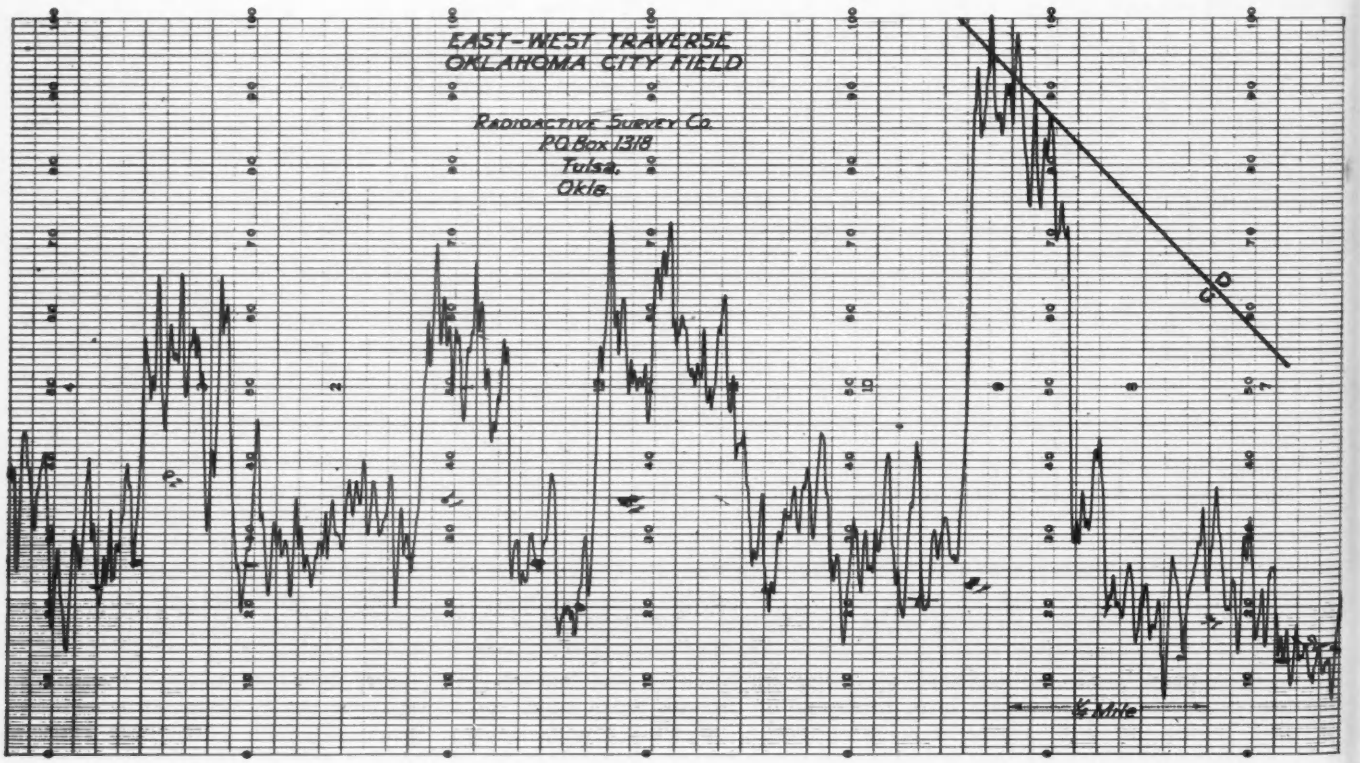


FIGURE 2

permanently mounted in the car, is extremely rugged, and will maintain its accuracy and dependability even though transported across terrain barely traversable by the carrying vehicle. For each station a stop is required, and the recorder must be allowed a minimum warmup time, although the pickup unit begins to function as soon as it is taken from its sponge-rubber carrying cradle and placed on the ground. It is not necessary to continue recording emanations at any one spot, as no increase in value will be shown after the maximum is reached in the first of the swings of the pen across the chart at the high for the area being surveyed. Fifteen minutes on a station is usually sufficient to obtain a clear record of the radioactive emanations at that point, and it is necessary only to replace the pickup unit in the car to again return the pen to the zero setting selected for the area under test. This zero setting is that shown by the pickup instrument when placed on a known dry or non-productive site close to the terrain under investigation. In virgin territory, however, it is necessary to select a scale which will keep the pen within the left-hand limits of the continuous chart while making the oscillations or swings which characterize the working of the recorder. Since no direct value is attached to the absolute readings of radioactivity at any given spot, but the differential between that recorded there as against readings with the same scale over adjoining areas affords the chart—and interpretation—data, choice of the scale used is determined solely by the basal radioactivity of the area under survey.

REFERENCES

[1] Stothart, R. A. "Tracing Wildcat Trends with Radon Emanations," WORLD OIL, Vol. 127, No. 10, p. 78. February, 1948.

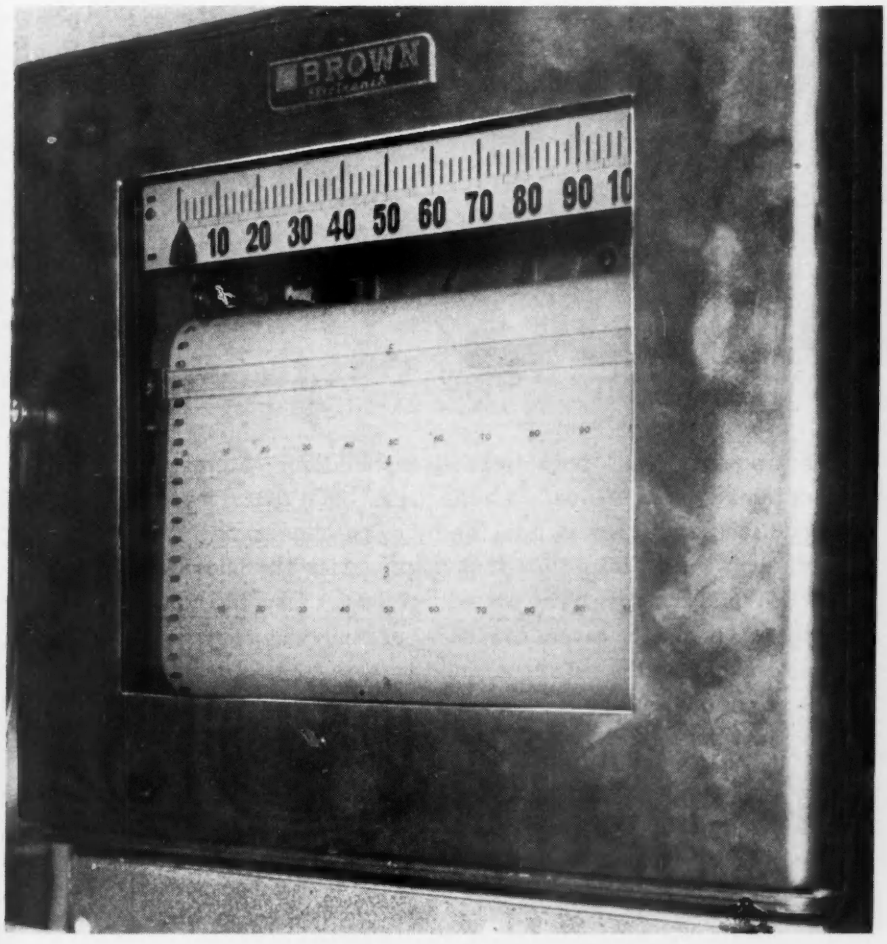
[2] Sterrett, Elton. "Radon Emanations Outline Formations." The Oil Weekly, Vol. 115, No. 4, p. 29. Sept. 25, 1944.

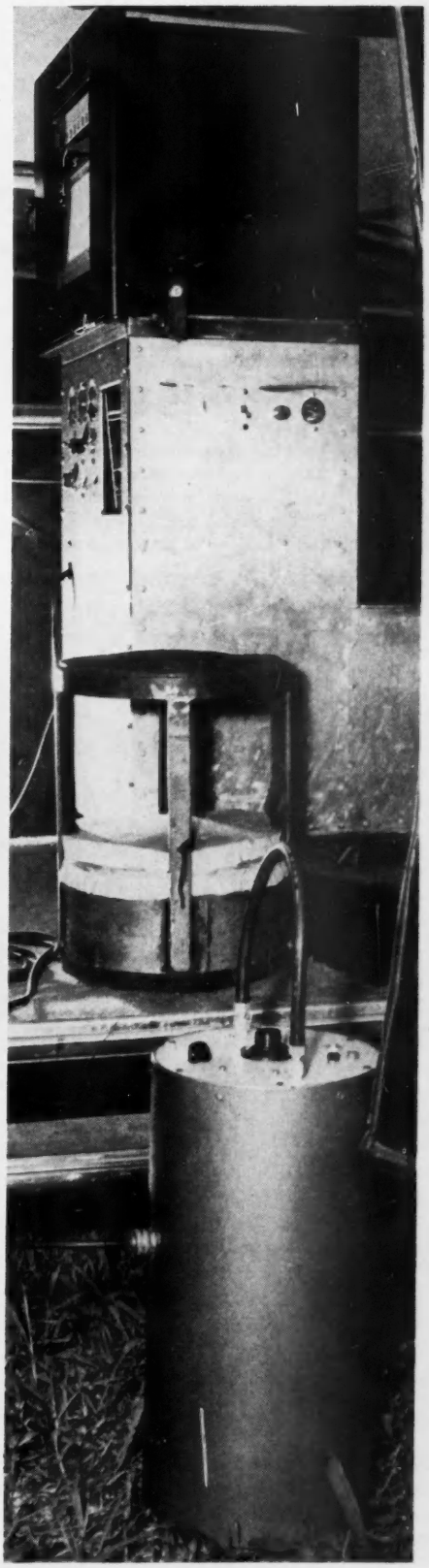
FIGURE 1 (top left). North-south traverse of a true reef-type field, Round Top, in Fisher County, Texas, with production from the Pennsylvanian, in the Canyon lime. Typical of such surveys is the return to dry-hole readings on the opposite side of the field beyond production.

FIGURE 2 (bottom left). East-west traverse across the Oklahoma City field, illustrating the type of readings obtained when crossing a fault. The characteristic tapering off of the amplitude of the chart highs closely parallels the productivity of the oil zone beneath, and would encourage test drilling.

FIGURE 3 (right). Typical radioactivity survey equipment, with pickup unit in foreground. Carrying cradle is in front of amplifier equipment.

FIGURE 4 (below). Recording instrument which registers on graduated chart emanations metered by the pickup unit.





Its Grand-Dad was a Wheelbarrow!

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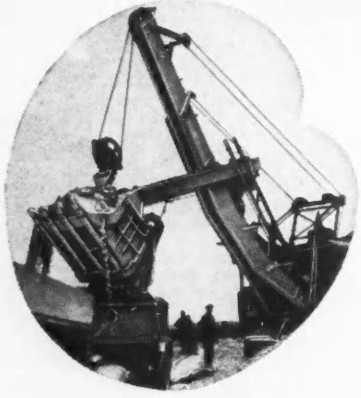
Looking like prehistoric monsters, modern earth-moving goliaths gobble up tons in the time Joe and his barrow moved pounds. Petroleum fuels and special lubricants speed their work—one of the triumphs of petroleum research.



Digging sand, laying concrete, breaking rock, excavating and construction machines must be lubricated to withstand exposure to heavy strain, shock, dust, mud and abrasives.

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THE TEXAS COMPANY

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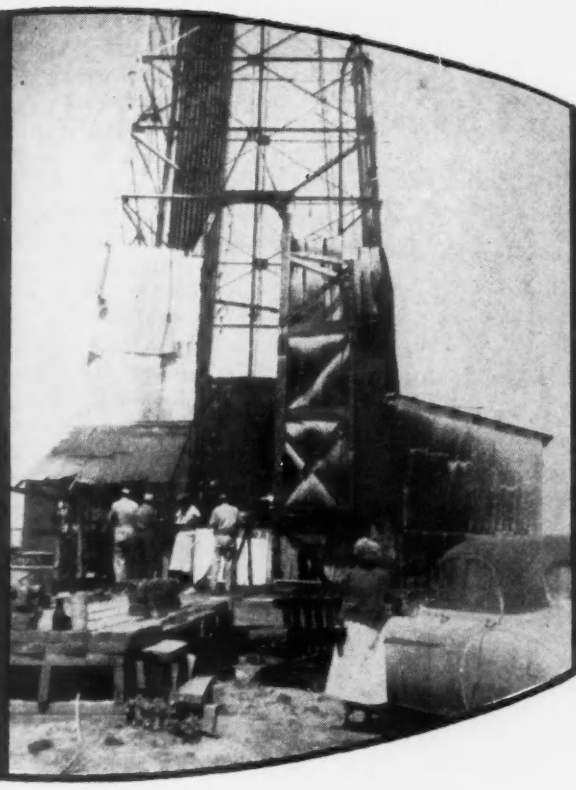
Oak Creek Discovery



View of Havenstrite Oil Company's Prentiss 1 discovery well at Oak Creek, taken while coming out of the hole with formation tester. On one hour and 45 minute test, 5800 feet of 37.9 gravity clean oil was recovered.

By GILBERT M. WILSON
Pacific Coast District Editor

OF CONSIDERABLE importance is the producing oil well, Prentiss 1, completed by Havenstrite Oil Company of Los Angeles in a wildcat area near Oak Creek, Routt County, northwestern Colorado. The discovery is significant, as it indicates possibilities of additional fields in a large surrounding area. Leasing activity has increased in the region because of the results obtained in this discovery well, and additional drilling activity is anticipated.

THE successful completion by Havenstrite Oil Company, Los Angeles, of their Prentiss 1 wildcat well in Routt County, Colorado, is regarded as a discovery of considerable importance for that state. It is the only significant oil discovery recorded for Colorado for 1949. Initial production of the well, pumping, was between 250 and 300 barrels per day of 37.9 gravity, clean oil. Production is from a 29-foot sand interval, 6670 to 6699 feet, in the Lower Morrison formation of Jurassic age. Total depth of the well is 6747 feet. It is believed that the well is capable of producing at a higher rate than that indicated in initial tests, but lack of storage prevented the making of a more conclusive test.

Situated 3½ miles west of the town of Oak Creek on the Denver and Salt Lake Railroad in southwestern Routt County, the well falls in the northwest corner, SW¼, NE¼ 2-3n-86w. It is approximately 19 miles southwest of Steamboat Springs. The discovery is located in fairly rugged terrain, as it is only about 25 miles west of the Continental Divide, and has the distinction of being the highest in the U. S., with an elevation of 9000 feet above sea level. Nearest oil production is the shallow Tow Creek field about 15 miles to the northwest and which produces from the Mancos Shale of Cretaceous age. The well is approximately 20 miles east and south of the Pagoda gas discovery completed in the Shinarump formation by General Petroleum Corporation in December, 1948.

The Oak Creek discovery was completed in August, 1949. Following installation of tankage and the conducting of production tests, the well was shut in for lack of storage. The company has moved the rig and has started work on a 990-foot northeasterly offset to the discovery well, and another operator has staked a tentative location for a well to the southwest of the discovery. It is understood that leasing activity by other companies soon may lead to staking of other tests in the area. The ruggedness of terrain, severity of the winters at this high elevation and remoteness from supply centers may affect the rapid development that normally would follow such a discovery.

Closure at Depth

The structure, originally known as the Yampa Anticline, and mapped and described by the U. S. Geological Survey in 1906, is a broad, northwest-southeast trending anticline. It lies near the eastern edge of a large sedimentary basin. Granitic outcrops occur only some four miles to the east of the structure.

Little or no closure is evidenced on the basis of surface geology alone, this probably accounting for the fact that no serious testing of the structure had been made up until the present time. On the basis of extensive reconnaissance and sub-surface correlation work done by Don Cook, petroleum engineer with Havenstrite, it was determined that a good possibility existed that closure might be found at depth. Other features which might govern closure were an east-west trending cross-fault on the southern part of the structure, and a high thrust fault on the east side of the area, the Oak Creek structure being on the upthrown side. The initial well was

drilled approximately one mile north of the cross-fault.

Leases in the area were acquired by Havenstrite in May and June, 1948, and included the interests of a small drilling company which, in October, 1947, had started a test well which was abandoned at 700 feet. For their first well, Havenstrite moved to a new location somewhat east of this shallow test, and spudded in Prentiss 1 in July, 1948. The drilling rig was a company-owned, heavy duty unit driven by butane-powered engines. Drilling was continued to November 22, 1948, at which time operations had to be shut down because of the severity of winter weather. Drilling was resumed in June, 1949, and by July 30, had been drilled to total depth. A drill stem test was made of the barefoot interval 6640 to 6747 feet. The tester was open for an hour and 45 minutes, during which time 5800 feet of clean oil, with no water, was recovered.

Production Tests

The casing program was conventional. A string of 13⅜-inch surface pipe was set at 545 feet, and after drilling to total depth, and after the formation test was made, a string of seven-inch casing was cemented in place, with shoe at 6637 feet. The hole is barefoot between the shoe and total depth.

The well would not flow naturally, despite the fact that the static fluid level stood close to the surface. Little gas accompanies the oil, probably no more than 20 cubic feet per barrel, so it is probable that a strong water drive exists in the field. A pumping unit was installed, and the well easily produced 285 barrels per day. It is believed that this figure is not a fair measure of the well's potential, for performance indicated that it was agitating-flowing when the pump was operating. On some occasions, the well flowed for a while after the pump had been shut down.

Lack of storage and transportation facilities have prevented making a more thorough test of the well's potential. At the present time, only about 5500-barrel storage capacity is available at the well. Some oil has been trucked out to the railroad station at Oak Creek. Ultimately, a pipe line may be laid down to the railroad for shipment of the oil to a refinery.

Lost Circulation Problems

The principal problem encountered in the drilling of the well was lost circulation. Despite the use of practically every substance available for overcoming lost circulation, numerous instances of circulation trouble occurred, principally in the highly fractured Mancos Shale of Cretaceous age which extended from about 300 feet down to 5340 feet. Several fishing jobs occurred, but these were cleared up without serious delay. Fishing jobs were complicated, however, by the fact that the nearest supply house was at Craig, Colo., about 70 highway miles northwest of Oak Creek. An airplane was used on several occasions to speed delivery of special equipment and personnel to the well. Generally flat dips, usually not to exceed three degrees, were encountered from surface to total depth. Maximum deviation of the hole at any point was not more than 1½ degrees. A total of 99 bits, including core heads, were used in drilling the well.

The formations penetrated in this well, and the depths encountered, are given in the following table:

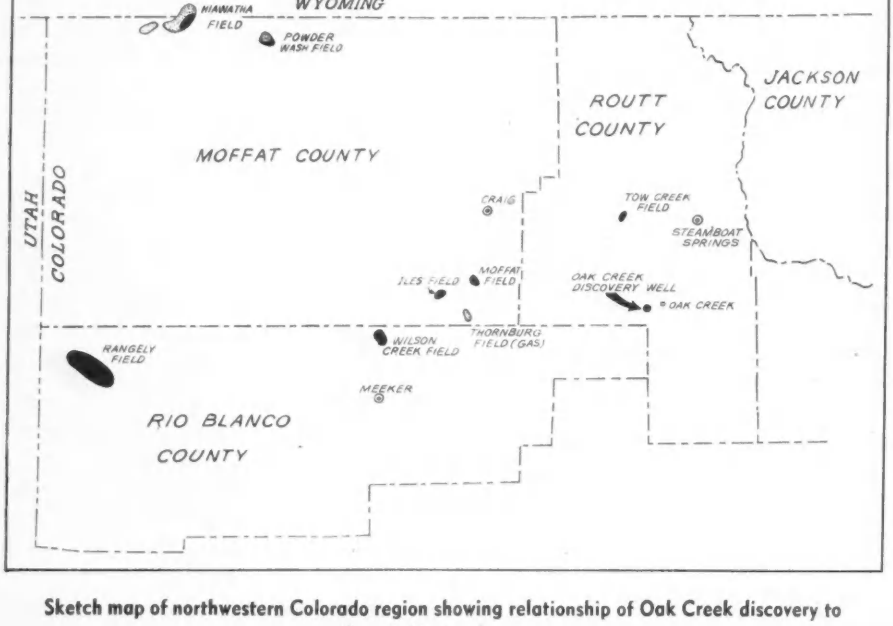
From	To	Formation
Surface	300	Mesa Verde (Upper Cretaceous)
300	5340	Mancos Shale (Cretaceous)
5340	5825	Frontier (Cretaceous)
5825	5900	Dakota (Cretaceous)
5900	6747 (TD)	Morrison (Jurassic)

The productive interval, as yet unnamed sand in the Morrison formation, was topped at 6670 and drilled to 6686 feet. A 13-foot core barrel then was run from 6686-99 feet, but only six inches of oil sand was recovered. Drilling was continued to total depth and an electric log survey was run. Based on the electric log interpretation, it was estimated that the sand interval 6670-99 would be producible, and the subsequent formation test confirmed that belief. Because of the small core recovery, little information on the porosity and permeability of the oil sand could be determined. However, from the core sample and cuttings taken from the ditch, it is known that the sand is vesicular and has good porosity and permeability.

Crude Analysis

Tests of the oil show it to be a mixed-base crude, containing 3.2 percent paraffine and 2 percent asphalt. API gravity of the crude is 37.9 degrees at 60° F. Gasoline content is 28.5 percent (tops by distillation) and sulphur content is slightly more than 0.25 percent. Viscosity Saybolt-Universal is 46 seconds at 100° and 34 seconds at 210° F. Pour point is 50° F.

With only one well on production, it obviously is too early at this time to draw any broad conclusions as to the probable extent of the new field. By the time two or three more wells are drilled, a much better picture of the structure and possible productive limits of the field will be known. Of significance in this discovery is the fact that it falls about 35 miles east of the nearest Morrison production, this being the Moffat (Hamilton) field in adjoining Moffat County. The Iles and Wilson Creek oil fields which fall on a rough line drawn southwest of the Moffat field, also obtain production from the Morrison formation. It therefore is reasonable to assume that the entire region between this group of three fields and the Oak Creek discovery will be given considerable attention. The expected—and already reported—increase in leasing activity in the region ultimately may lead to additional drilling activity in this part of northwestern Colorado.



Sketch map of northwestern Colorado region showing relationship of Oak Creek discovery to other fields in the area.

A Cross-Section Board

By B. OSBORNE PRESCOTT
Geologist, Shell Oil Company,
Oklahoma City

The finished product.

CROSS-SECTIONS play an important part in the solution of geologic problems and in the illustration of geologic thought. Much time is consumed in drafting the basic cross-section before the geologist may make his correlations. When correlating large sections on a table or desk, it is difficult to view the problem as a whole, or even to see more than two or three of the logs under consideration. These difficulties are removed by correlating the logs on a large bulletin board. Correlations are shown with string and tacks. This method is not new, and has been used by many in the petroleum industry; however, photographic preservation of these correlations is believed to be a new idea.

Board Construction

Figure 1 gives the specifications of the board. Although the construction may be changed to suit individual tastes, certain specifications are controlled by the dictates of location and procedure. The finished board should stand not more than 6 feet, 10 inches, in order to pass through the standard seven-foot doorway. Maximum utility requires that the inside dimensions of the correlating surface be of the proportions of an 8- by 10-inch photograph. Both surfaces receive two coats of a flat white waterbase paint to eliminate glare. The board itself should take pins or map tacks with ease. This requirement would recommend a material like glaze coat fiber wall board. The largest wall board paneling available is 4 by 8 feet. Two thicknesses of 5/16-inch wall board, made from three 4 by 7½-foot panels, are glued together with the joints offset. This will make a firm working surface. The replacement of wornout boards is facilitated by using molding held in place with screws. The screen-door turnbuckle guys are not only for stability but also to plumb the board, to reduce distortion in the final photograph.

Additional Materials

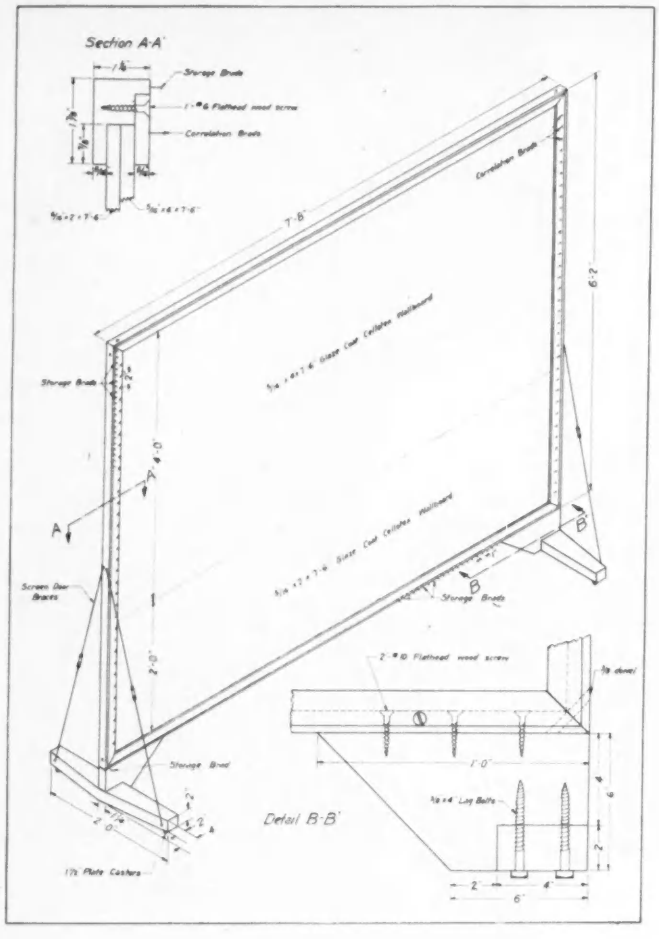
About 25 correlating lines are made from ten-pound test, black, nylon casting line. To make the lines, tie a bowline knot in one end of the nylon line, place the loop thus formed over the highest storage brad, pass the line down and around the single brad in the lower left hand corner of the frame, and thence to the right to the first bottom storage brad. Cut the line four inches longer than this length and tie on a two-ounce swivel casting sinker. This will make a line about 11½ feet long. In addition, three or four lines six feet long should be constructed. Ten lines to depict unconformities are made in the same manner as the correlation lines, using intertwined red and white No. 5 pearl crochet cotton and one-ounce sinkers.

Correlation points are indicated by solid colored, size 100 maptacks. Casing perforations are shown by white maptacks with a red line. Logs are held in position on the board with white-headed thumb tacks.

A set of signs (formation names, etc.) is printed on white artist's board. On the back of each of these small signs are two thumb tacks, held in place with gummed linen tape. The plotting staff of a long log strip is used as a scale.

Construction of Cross-Section

One of the black correlation lines is hung horizontally on the board as a datum or sea-level line. Starting at either



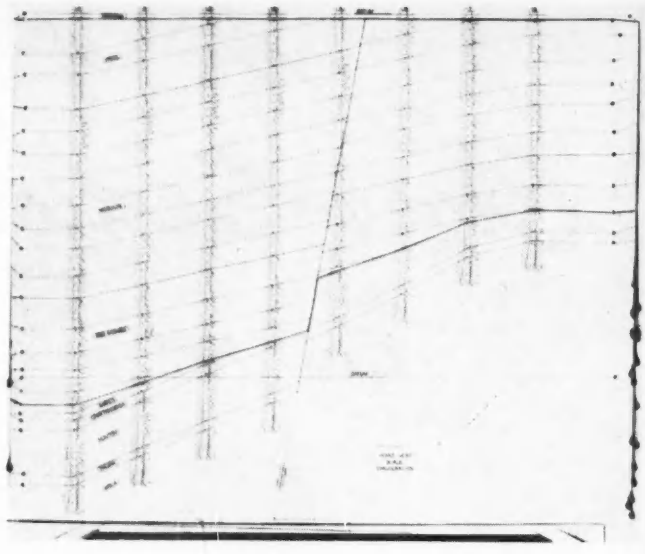


FIGURE 1 (left). Construction details of the board.

FIGURE 2 (above). Well logs mounted on cross-section board demonstrate ease with which horizons can be correlated at a glance.

end, the first log is positioned in relation to the datum line with a white-headed thumb tack at the top. One of the 6-foot lines is looped over this thumb tack and used as a plumb bob to align the log vertically. The log is now thumb tacked at the bottom and the plumb bob removed. Using the scale, the next log is positioned and the above process repeated. With electric logs the heading or detail log may be folded under. With sample logs or a like stiff paper log the unused portion is looped up and over, or down and under the board and held on the other side by a thumb tack.

Correlations are indicated with maptacks, and each set of correlations connected with one of the lines. The maptacks are only partially depressed so as to allow slippage of the lines while correlating. A fault is constructed by use of the six-foot lines, offset correlation lines being held with maptacks. When all correlations are completed, lines which extend beyond the end logs are held horizontally with thumb tacks, the maptacks are depressed, and signs placed on the board. Figure 2 shows one side of the board ready for the photographer.

Photographic Procedure

The 8- by 10-inch photograph is made on orthochromatic type 2 film, using an ASA film speed rating of 3. Illumination is furnished by two No. 2 photo floods in reflectors. These two lights are "wiped" across the board during the exposure by moving them vertically from top to bottom of the board while pointing them from a central position near the camera toward the outer edges of the board. This produces an even, shadowless picture. The film is developed by inspection in a high-contrast developer. This process yields a negative of extreme contrast, with very clear whites and dark blacks, very little background or blocking, and great definition.

The negative is then frisketed or outlined with black or red photographic scotch tape to eliminate unwanted parts of the photograph. An enlargement up to three-quarters of the original scale is made on matte film with no important loss of definition. In making this enlargement the negative is placed in the holder with its emulsion away from the emulsion of the matte film. This facilitates making additions with India ink to the matte surface of the enlargement. Erasures or corrections on matte film are made with an erasing fluid. When all corrections and additions have been completed final prints are made by a positive reproduction process and may be colored.

Conclusion

The actual processing of a cross-section from blank board to final reproduction may be done in as little as two days. This is a substantial saving over the normal two or three weeks needed to prepare such cross-sections by the usual drafting methods. Cost is reduced appreciably, and the resulting illustration will compare favorably with sections prepared by other methods.

One advantage of using this board is that all of the section under preparation is viewed in its entirety. Also, several geologists can collaborate on one section. Any changes in correlations are much simplified, since instead of erasing pencil lines and replacing them, a maptack is moved, and the line slides to the new correlation. Geologists will find that with a little practice correlations are more easily made since facies changes and other anomalous conditions may be viewed in a broader sense.

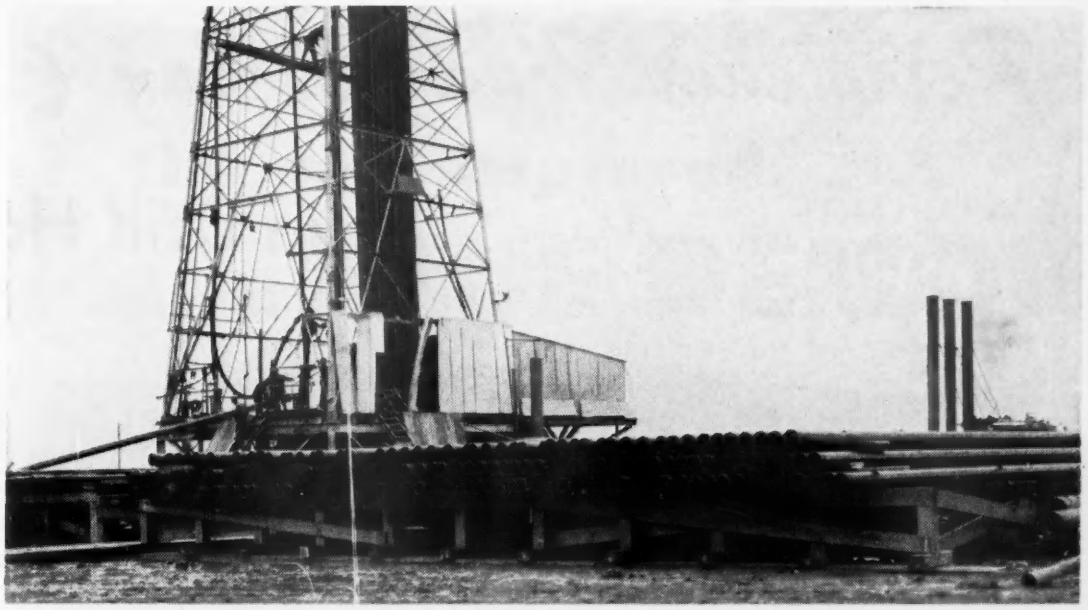
The greatest advantage is to those geologists who have a limited personnel available for drafting, and who now can construct cross-sections with a minimum of drafting and cost.

The method is cheaper, faster, more versatile, and the results more easily filed.

ACKNOWLEDGMENTS

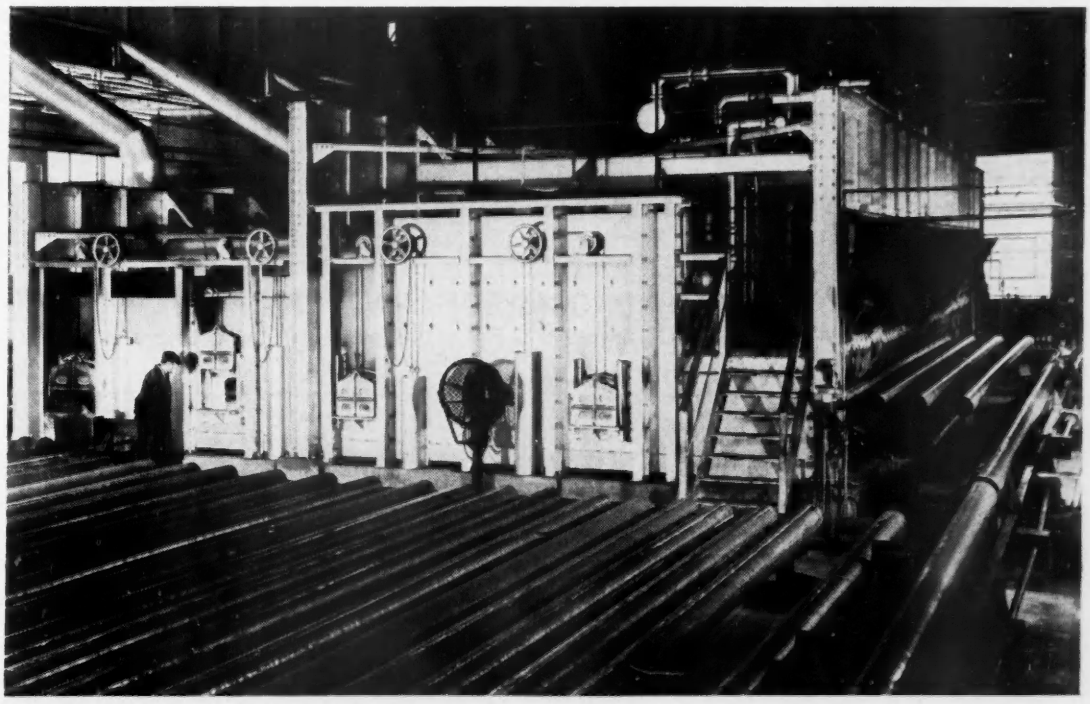
Thanks are extended to the personnel of Meyers Photo Shop in Oklahoma City, for their efforts which have led to the solution of the photographic problems encountered in this work, and members of Shell Oil Company's Oklahoma City staff, who made pertinent and constructive contributions.

DEPENDABILITY THROUGH



IN THE FIELD, LOUISIANA: Running a 9200-foot string of 9⅝-inch S-80 A.O. Smith Casing.

RESEARCH AND ENGINEERING



IN THE A. O. SMITH PIPE MILL: A special furnace used for normalizing A.O. Smith Casing.

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The Four Types of *Petroleum Hydrocarbon Curves* in Drill Holes

By ORTON E. CAMPBELL

A RECORD of petroleum hydrocarbons in drill holes is part of a complete exploration picture, according to continued experience in fluorologging.

Fluorologs of producers, edge wells, outpost wells and wells still more distant from production, show that the hydrocarbon curve on a drill hole is characteristic of its position relative to an oil accumulation, and that there are four types of hydrocarbon curves.

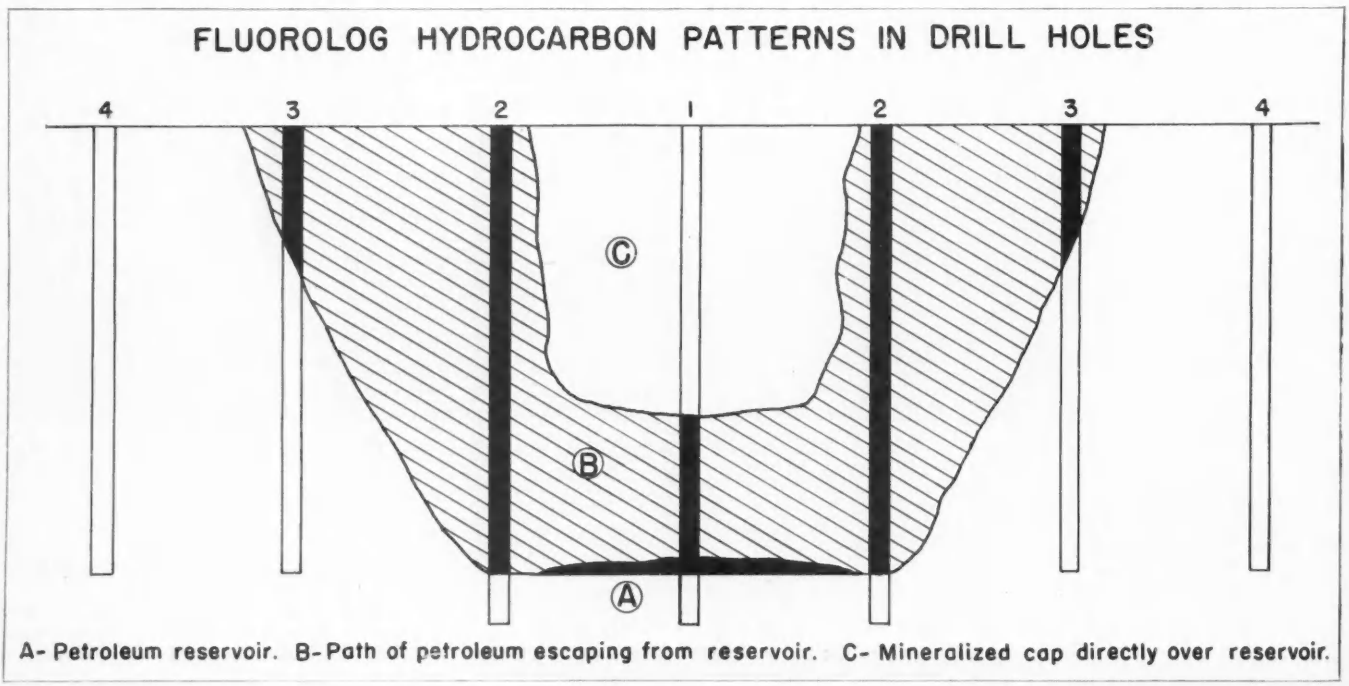
In the accompanying diagrammatic illustration Wells 1 to 4 represent: 1, a producer; 2, an edge well dry hole; 3, an outpost dry hole; and 4, any well more than 4000 feet from an accumulation.

A producer (Type 1) develops a low hydrocarbon curve at the top and a high curve in the lower section above the pay. An edge dry hole (Type 2) will record a high curve from the surface to the horizon of the pay. Outposts dry holes (Type 3) start with a high hydrocarbon curve, which fades out at a shallow depth. A duster in dry territory (Type 4) develops a low curve from top to bottom.

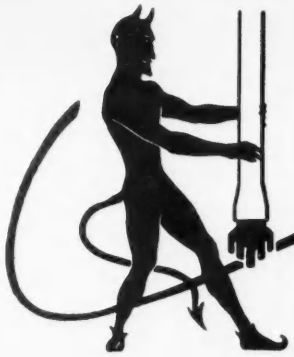
Reservoir Cross-Section

The illustration is a cross-section through the petroleum reservoir A and the overying geochemical anomaly consisting of C and B. The mineralized plug C, directly over the reservoir, stops the vertical rise of hydrocarbons escaping upward from A, and they turn outward and then upward through the bowl-shaped space B. Hence, the pattern of the hydrocarbon curve of a dry hole in the vicinity of a petroleum reservoir depends upon its location relative to the geochemical anomaly and the reservoir.

Petroleum hydrocarbon logs are always valuable, but they are especially valuable in exploring for stratigraphic reservoirs. For instance, fluorologs of two dry holes in the same locality, one developing a Type 3 or 4 curve and the other a Type 2 curve, point to the location of the reservoir sought. To explore for a reservoir it is not necessary to drill to the horizon of the pay. Curve Type 2 is distinctive and can be recognized at a shallow depth in core holes. Three core holes across a prospect will indicate and ordinarily locate any subsurface accumulation present.



A- Petroleum reservoir. B- Path of petroleum escaping from reservoir. C- Mineralized cap directly over reservoir.



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1949 Exploration

May Top Record by 10 Percent

By CECIL W. SMITH
Statistical Editor

AN INCREASE in the number of exploratory wells completed in November compared with the previous several months boosted the year's 11-month total to a 9.8 percent lead over the record activity in 1948. At the end of October 9.7 percent more wells had been drilled and it then appeared that activity was slackening, and although it was certain that 1949 would top the previous year's record, it appeared that it would do so with a somewhat smaller margin than it held at the time. But with November's upswing adding its weight, 1949 should end with almost 10 percent more wells completed for a new all-time high mark.

Although more wells were completed in November than had been drilled in the two preceding months, the ratio of producers to dry holes did not quite keep pace. Of 646 tests completed, 122 were rated as commercial producers for a score of only 18.9 percent, while a month earlier almost 21 percent were completed successfully. Nor did November's luck measure up to the year's success average of 20.5 percent.

In 11 months, 6813 exploratory wells had been drilled to top the previous year's 6203 by 9.8 percent. Not only has 1949 wildcatting been done on a larger scale than in any year in history, but its

Summary of Results of Exploratory Drilling

ITEM	Nov., 1949	Oct., 1949	Eleven Months: January-November 1949	1948	Percent Diff.
Oil Discoveries	71	79	856	802	+ 10.5
New Fields	53	57	617	546	+ 13.0
New Pays	18	22	269	256	+ 5.1
Distillate Discoveries	7	5	116	97	+ 19.6
New Fields	5	3	66	61	+ 8.2
New Pays	2	2	50	36	+ 38.9
Gas Discoveries	12	11	136	125	+ 8.8
New Fields	8	9	111	90	+ 23.3
New Pays	4	2	25	35	— 28.6
Total Discoveries	90	105	1138	1024	+ 11.1
Extensions to Fields	32	31	262	194	+ 35.1
Oil Fields	30	26	234	155	+ 51.0
Distillate Fields	1	2	15	16	— 6.3
Gas Fields	1	3	13	23	— 43.5
Total Prod. Tests	122	126	1400	1218	+ 14.9
Dry Holes	524	486	5413	4985	+ 8.6
Wildcats	500	464	5306	4915	+ 8.0
New Pays	4	3	14	11	+ 27.3
Outposts	20	19	93	59	+ 57.6
Total Expl'tory Tests	646	612	6813	6203	+ 9.8
Percent Productive	18.9	20.6	20.5	19.6	
Percent Dry	81.1	79.4	79.5	80.4	

Results of Exploratory Drilling in November and First 11 Months, 1949-1948, by Districts

State or District	MONTH OF NOVEMBER, 1949														FIRST ELEVEN MONTHS, 1949																	
	Productive Tests									Total Productive	Unproductive Tests			Total Exploratory Tests	Productive Tests									Unproductive Tests				Total Exploratory Tests	
	New Fields			New Pays			Extensions								New Fields			New Pays			Extensions			Total Productive				Total Dry			
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	11 Mo. 1949	11 Mo. 1948	Wildcats	New Pays	Outposts	11 Mo. 1949	11 Mo. 1948	11 Mo 1949	11 Mo. 1948
Alabama																										11			11	19	11	19
Arizona																										5			5	1	5	1
Arkansas											6		1	7	6		2	5			1			14	8	67	1	4	72	98	86	106
California	1			1						2	30	2	5	39	10		3	10			14		2	39	50	328	7	12	347	188	386	238
Colorado											4			4	1									1	6	41		1	42	46	43	52
Florida											1			1												14			14	23	14	23
Georgia																										4			4	3	4	3
Illinois	4			1			4		1	10	59			69	22			31			51		2	106	88	564			564	495	670	583
Indiana	2									2	15			17	36		3	3			5			47	40	332			332	259	379	299
Kansas	4									4	56			60	71		5	4			6			86	75	374			374	432	460	507
Kentucky	2			1						3	9			12	14			1			2			17	8	52			52	49	69	57
Louisiana	2	1	1				2			6	21			27	28	16	5	27	15	1	11	2		105	113	206		1	207	225	312	338
North Louisiana	1		1				1			3	11			14	8	4	2	5	8		4			31	23	115			115	121	146	144
South Louisiana	1	1					1			3	10			13	20	12	3	22	7	1	7	2		74	90	91		1	92	104	166	194
Maryland																	1							1						1	1	1
Michigan	2									2	27			29	18		2			1	5			26	20	282		1	283	223	309	243
Mississippi											7			7	5	1		2						8	7	104		3	107	105	115	112
Missouri																										13			13	21	13	21
Montana	1									1	2			3	4	1	1	1			1			8	5	34		1	35	33	43	38
Nebraska											2			2	1									1		7			7		8	
New Mexico	1						1			2	6		1	9	13		2	5			3			23	18	54		3	57	74	80	92
North Dakota											1			1												4			4		4	
Ohio							1			1	2			3							3		1	4	12	31			31	36	35	48
Oklahoma	3		1	2		2	3			11	48			59	57	3	8	24	2	5	24	1		124	104	410			410	410	534	514
Pennsylvania											1			1			2							2		2			2	4	4	4
South Dakota																										6			6	1	6	1
Tennessee															1									1	2	20			20	35	21	37
Texas	30	4	4	13	2	2	18	1		74	186	2	12	274	314	45	65	146	33	18	98	12	8	739	615	2197	6	59	2262	2110	3001	2725
Dist. 1 S. Central				1						1	19		1	21	15			2			3		1	21	10	212		5	217	173	238	183
Dist. 2 Middle Gulf		1	2	3			1	1		8	8			16	9	16	12	9	8	4	2	6	3	69	70	141		6	147	171	216	241
Dist. 3 Upper Gulf	2	2		3			1			8	18	1	2	29	17	15	7	46	11	3	6	3	1	109	113	216	1	5	222	251	331	364
Dist. 4 L. Gulf-SW	4	1		1	2	1	1			10	19		1	30	19	11	15	34	12	8	6	1	1	107	96	294	1	8	303	315	410	411
Dist. 5 E. Central						1				1	5			6	2	1				1		1		5	7	66		1	67	82	72	89
Dist. 6 Northeast	1									1	6	1	1	9	11	2	2	1	2			1	1	20	20	65	2	2	69	61	89	81
Dist. 7-B N.Central	14		1							15	41		3	59	105		16	17		1	8			147	117	505	2	7	514	389	661	506
Dist. 7-CW. Central	2		1	2			2			7	14			21	17		4	10			11			42	22	94		3	97	84	139	106
Dist. 8 West	2			2			9			13	18		2	33	34		2	12		1	43		1	93	81	166		10	176	171	269	252
Dist. 9 North	5			1			4			10	38		2	50	84		7	15			19			125	77	432		12	444	407	569	484
Dist. 10 Panhandle															1									1	2	6			6	6	7	8
Utah											1			1	2						1			3	5	20		1	21	13	24	18
Virginia											1			1											1	1			1	1	1	1
Washington																														2		2
West Virginia			1							1	1			2			11							11	4	5			5	4	16	8
Wyoming	1		1				1			3	14		1	18	14		1	10			9			34	37	118		7	125	75	159	112
Total U. S.	53	5	8	18	2	4	30	1	1	122	500	4	20	646	617	66	111	269	50	25	234	15	13	1400	1218	5306	14	93	5413	4985	6813	6203

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success from the standpoint of producer-to-failure has lent encouragement. Of the year's total wells, 1400 proved to be producers and they amounted to 20.5 percent of the over-all. In the same period of 1949, successful tests had totaled 1218 or 19.6 percent. Of course, these comparisons are on numerical basis only with no regard to quality of the results, but it would be safe to say that the year's work located its share of new reserves and perhaps much more than in many previous years.

New oil discoveries so far in 1949 have been 10.5 percent more numerous than they had been in the first 11 months of 1948. Through November they totaled 886 against 802 in 1948. These were comprised of 617 new oil fields compared with 546 the previous year, and 269 new oil horizons in established fields against 256.

Gas-distillate discoveries have shown an even greater increase. They totaled 66 new fields against 61 and 50 new pay horizons to 36 for 116 new pools to 97, an increase of 19.6 percent.

Dry natural gas discoveries also showed a substantial increase, but not quite as much percentagewise. New gas strikes numbered 136 in 1949 against 125 a year ago and this amounted to a gain of 8.8 percent. New gas fields totaled 111 to 90 for a better record, but new gas pays dropped to 25 from the previous year's 35.

The class of exploratory wells to compile the best record of the year were the outposts—wells attempting to extend new field productive limits by at least one-half mile. Outposts to oil fields managed to fulfill their mission in 234 instances, while a year ago only 155 extensions were made. That was a gain of 51 percent. Outposts to distillate and gas fields did not fare so well. Fifteen distillate fields were extended, but by the same time the previous year 16 had expanded. Moveouts in the dry gas fields amounted to only 13 and a year ago they totaled 23.

New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in November, 1949

Also Important Extensions to Established Fields

(CONTINUED)

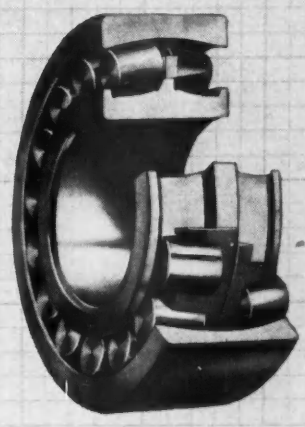
COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		CALIFORNIA—New Oil Field						
Kern		Rothschild Oil Co's Giumarra 1, 25s 300e fr center 22-30s-29e, midway btw Edison and Edison, W. flds.	10-29-49	3029	2476- 2713 2900- 2954	Chanac sd; Plio Sta. Margarita sd; Mio	P 114; 9 wtr	16.6
		CALIFORNIA—New Oil Pay						
Kern	Tejon Hills	O. M. Slosson's Tejon 2, 5?9 n 871 e fr SWC 15-11n-18w	11-21-49	430	400- 430		P 30	28.9
		ILLINOIS—New Oil Fields						
Christian	Edinburg	Paul Doran et al's Earl Heater 1, NW NE NW 15-14n-3w, 8 mi sw Auburn pl.	11-15-49	1853	1812- 1814	Devonian li; Devo	P 8	
Coles	Westfield, N.	B. W. Quick's B. Steele 1, NW NW NW 17-12n-14w, 3 mi n Westfield pl.	6-21-49	507	488- 504	Pennsylvania sd; Penn	P 2	
Edwards	Mitchell	The Texas Co's E. E. Foster 1, SE SW SE 30-2s-10e, 1¼ mi se Ellery pl.	11-15-49	3329	3305- 3310	McClosky li; Miss	P 156	
Hamilton	Cantrell	J. W. Everhart's Wesley Foundation 1, SW SW SW 5-7s-5e, 1½ mi e Thompsonville, E. pl.	11-29-49	3216	3200- 3215	Aux Vases sd; Miss	F 525	
		ILLINOIS—New Oil Pay						
Marion	Raccoon Lake	The Texas Co's G. Griner 2, SW SW NE 3-1n-1e	11-22-49	1955	1886- 1891	L. O'Hara li; Miss	P 142; 22 wtr	
		ILLINOIS—Oil Field Extensions						
Coles	Westfield, N.	George Zicos' Martha Fender 1, NW NE NE 17-12n-14w, ¾ mi e extension	11- 1-49	611	275- 281	Pennsylvania sd; Penn	P 2; 36 wtr	
Edwards	Maplegrove, E.	F. Lomelino's A. B. Seibert 1, 1951 fr nl 330 fr wl 7-1n-14w, ½ mi e extension	11-15-49	3275	3201- 3207	McClosky li; Miss	P 1	
Fayette	Louden	H. Luttrell's Rhodes 1, NW NE NE 3-7n-3e, ¾ mi e extension	11-15-49	1587	1572- 1586	Cypress sd; Miss	P 192	
Richland	Olney Cons.	F. Lomelino et al's H. Graves 1, SW NW SE 14-4n-10e, ½ mi extension	11-22-49	3065	3051- 3054	Rosiclare li; Miss	P 19	
		ILLINOIS—Gas Field Extension						
Edgar	Dudley	L. G. Stableford's Bernard Waller 1, NE SE SE 28-14n-13w, 1 mi n ext.	11-15-49	460	280- 289	Pennsylvania sd; Penn	0.3 mln	
		INDIANA—New Oil Fields						
Posey		C. E. Skiles' Luigs-Helfert-Schauss 1, SE SW NW 25-5s-12w, 1 mi s St. Wendell, E. fld.	11-16-49	2286	2280- 2286	Cypress sd; Miss	P 20; 100 wtr	
Warrick		V-T Drilling Co's Tom Helm 1, SW SW NW 23-6s-8w, 5 mi nw Hatfield pl.	11- 2-49	1886	1558- 1565	Cypress sd; Miss	P 40; 21 wtr	
		KANSAS—New Oil Fields						
Barton		Aladdin Pet. Corp. & Crowe Drlg. Co's Schartz 1, SE SE NW 14-19s-12w, 1 mi n of Hammer, N. pl.	11-29-49	3447	3141- 3174	Lansing-K.C. li; Penn	P 98	
Barton	Cheyenne View	Aladdin Pet. Corp. & Crowe Drlg. Co's Kultgen 1, SW SW NW 12-19s-12w, 2 mi ne of Hammer, N. pl.	11-25-49	3412	3387- 3412	Arbuckle li; Ord	P 120	
Ellis	Emmeram, NE.	E. H. Adair's Froelich 1, SW SE SE 27-12s-16w, 2 mi ne Emmeram pl.	11- 4-49	3544	3540- 3544	Arbuckle li; Ord	P 203	38
Sumner	Alton	Champlin Rfg. Co's Slentz 1, NW NW NW 10-35s-2w, 4½ mi sw Corbin pl.	11- 8-49	4719	4709- 4719	Simpson li; Ord	F 9[illegible]	46
		KENTUCKY—New Oil Fields						
Daviess		Jim Ladas' Drury-Neely 1. NW SE SE 11-N-29	11-30-49	1449	1432- 1440	Bethel sd; Miss	P 8	
Daviess		George & Wrather Drlg. Co.-Ryan Oil Co's McCann 1, SE NW SW 18-N-28, 1 mi n Glenville.	11-29-49	1875	1870- 1874	O'Hara li; Miss	P 3	
		KENTUCKY—New Oil Pay						
Webster	Dixon	F. T. Shelton et al's Mattie Ramsey 2, NW NW SE 21-M-22	11-12-49	2122	2089- 2099	Pennsylvania sd; Penn	P 78; 40 wtr	
		NORTH LOUISIANA—New Oil Field						
Concordia		Hunt Oil Co. et al's Metropolitan Museum of Art et al 1, 2500 s 405 w of NEC 29-3n-7e, 5 mi s 8 mi w of Bougera.	11-23-49	8548	6919- 6924	Wilcox sd; Eoc	F 153; ¼"	52.1
		NORTH LOUISIANA—Oil Field Extension						
Richland	Big Creek	Stanolind O&G Co's Dr. Carl G. Pardue 1, 2320 fr el 2309 fr sl 9-16n-7e, 1½ mi w extension.	11-28-49	2998	2616- 2621	Tuscaloosa sd; U. Cre	F 51; 7/32"	36
		NORTH LOUISIANA—New Gas Field						
De Soto		E. C. Laster's C. F. Grimes 1, C SE NW 26-15n-14w, 4 mi e 1 mi s Stonewall	11-15-49	5284	5110- 5136	Anhydrite; L. Cre	No gge	
		SOUTH LOUISIANA—New Oil Field						
Calcasieu		Niloco Co's Industrial Lbr. Co. 2, 1758 fr nl 994 fr el Sect. 2-8s-11w, 1¾ mi w-sw of Perkins fld.	11- 1-49	6750	6654- 6664		F 239; 5/32"	29.5
		SOUTH LOUISIANA—Oil Field Extension						
Rapides	Big Island	Union Prod. Co. & M. H. Marr's Hudson 1, NW NE 11-4n-3e, 1 mi n extn.	11-14-49	10223	5565- 5567	Wilcox sd; Eoc	F 390; 7/32"	46.9
		SOUTH LOUISIANA—New Distillate Field						
Terrebone		Shell Oil Co's Continental Land & Fur Co., Inc. 1, NW SE 32-17s-14e, 4½ mi n-ne Bayou Penchant Dome.	11-29-49	12002	11980-11988		F 65; 4/16"	47.5
		MICHIGAN—New Oil Fields						
Allegan		Robert Devine, Clyde Miller & J. W. Lang Co's Brenner et al 1, NW SE SW 36-3n-13w, 3 mi se Monterey, S. fld.	11- 4-49	1518	1507- 1509	Traverse li; Miss	P 10	
Kalamazoo		William C. Vanderberg Jr's Reynolds 1, SE SE SW 5-2s-10w, 4 mi ne Kalamazoo.	11- 8-49	1435	1430- 1434	Traverse li; Miss	P 30; 75 wtr	
		MONTANA—New Oil Field						
Rosebud		The Texas Co's Northern Pacific RR 1-E, NE NE NE 5-9n-34e, nw of Ingomar Dome, se of Ragged Point fld.	11-22-49	6006	4389- 4414	Amsden sd; Penn	P 55	
		NEW MEXICO—New Oil Field						
Eddy		A. T. Wright's Yates 2 NW NW NE 7-20s-27e, se McMillan fld.	8- 3-49	652	651- 652		P 35; 138 wtr	38
		NEW MEXICO—Oil Field Extension						
Eddy	Turkey Track	Jones & Watkins' Samwell-State 1, NE NW NE 15-19s-29e, ¾ mi s extn.	11-16-49	2262	2235- 2262	Queen sd; Perm	P 25	35
		OHIO—Oil Field Extension						
Vinton	Southern	J. B. Grogg & Son's Arthur Ellis 1, SE SE Sect. 25, Knox Twp. 2 mi se of Bolins Mills pl.	10-26-49	1102	1101- 1102	Berea sd; Miss	Sw 7	

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian: U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

keeping a whip hand over the drill string...

TORRINGTON BEARINGS



It takes rugged equipment to control a mile and a half of drill pipe lashing around at high speed.

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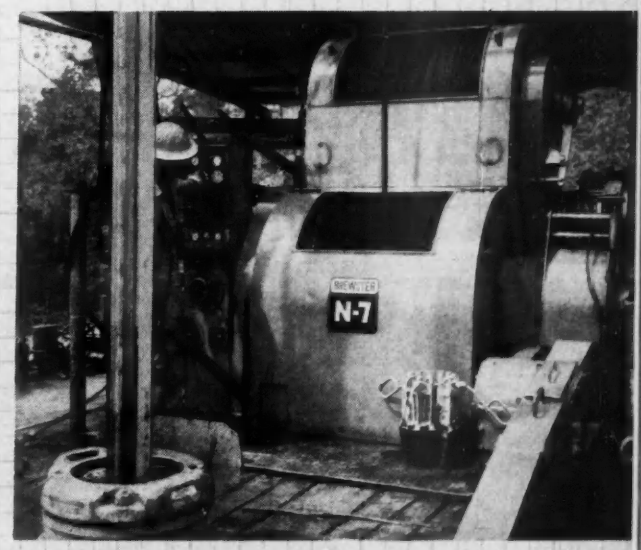

TORRINGTON *SPHERICAL ROLLER* **BEARINGS**

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in November, 1949

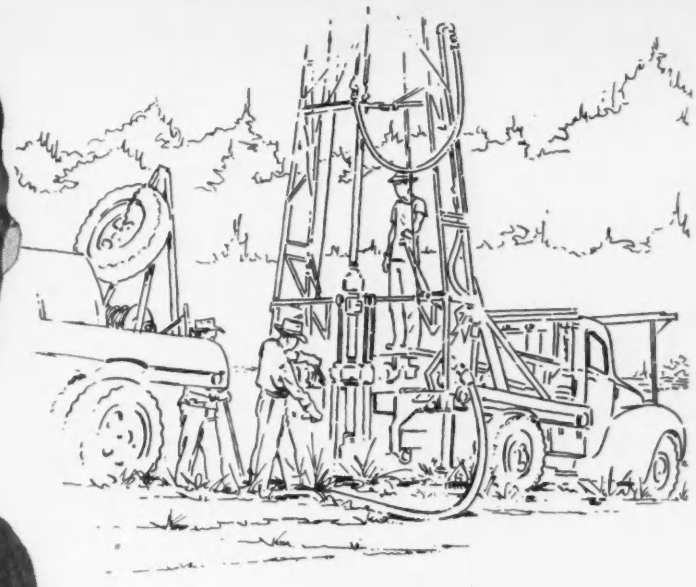
Also Important Extensions to Established Fields

(CONTINUED)

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		OKLAHOMA—New Oil Fields						
Garfield	Hunter, NW.	A. G. Oliphant's M. Hoover 1, NE SW SE 2-24n-5w	11- 8-49	6220	6202- 6220	Wilcox sd; Ord	F 255; 3/16"	44
Osage		A. G. Oliphant's Osage 1, SE SE SW 22-25n-2e, 1 mi e Big Bend pl.	11- 1-49	3789	2675- 2686	Layton sd; Penn	P 75	
Seminole	Transco, NW.	Keener O&G Co's Norvell 1, SW SW NW 20-7n-7e, ¾ mi nw Transco, W. pl.	11- 3-49	1784	1774- 1779	L. Calvin sd; Penn	F 100; 7/32"	33
		OKLAHOMA—New Oil Pays						
Garvin	Maysville, SW	The California Co's Robert Roller Unit 1, NE NW NW 36-4n-3w	11-30-49	8666	8532- 8540	Oil Creek sd; Ord	F 247; 3/4"	43.5
Okfuskee	Blakely	Mid-Continent Pet. Corp's Weehunt 8, SW SE SE 6-11n-11e	11- 2-49	2842	2837- 2841	Gilcrease sd; Penn	F 50; 1/4"	39
		OKLAHOMA—Oil Field Extensions						
Carter	Hewit	Geo. Blaylock's Dillard 1, SW NW SW 27-4s-2w, ½ mi s extension	11- 7-49	6230	3102- 3130	Lone Grove sd; Penn	P 18	32
Major	Ringwood, W.	C. Andrade III & D. H. Rowland's Atlantic School Ld 1, NE SE NE 36-22n-11w.	11- 9-49	6943	6790- 6900	Manning sd; Penn	F 100; 1/4"	
Seminole	Cromwell	Woods Drlg. Co's Norvell 1, SE SW NE 34-11n-8e, e extension	11-22-49	3396	3372- 3389	Cromwell sd; Penn	P 8	
		OKLAHOMA—New Gas Field						
Lincoln		Sterling Oil of Okla., Inc's Lohaus 1, SW SE NW 21-17n-5e, 4 mi s Cushing, 1 mi n Agra, N. pl.	11-14-49	4090	3556- 3580	Bartlesville sd; Penn	1 mln	
		OKLAHOMA—New Gas Pays						
Comanche	Ft. Sill, N.	Texola Drlg. Co's J. L. Brown 1, SE SW NW 24-4n-11w	11-10-49	3002	2650- 2775	McLish sd; Ord	1.1 mln	
Okfuskee	Blakely	Mid-Continent Pet. Corp's G. R. Weehunt 7, NW NE SE 6-11n-11e	11- 7-49	3851	3661- 3672	Misener sd; Miss	1.3 mln	
		TEXAS—District 1 (S. CENTRAL)—New Oil Pay						
Caldwell	Staples	Fred J. Adams' C. J. Ohlendorf 1, 338 fr nel 150 fr nwl of 200-ac Tr, S. B. Morrison Sur.	8-29-49	882	860- 882		P 32	30
		TEXAS—District 2 (MIDDLE GULF)—New Oil Pays						
Goliad	Cabeza Creek, S.	Continental Oil Co's Elmo Reed 3, 450 fr n&wl Geo. Elliott Sur.	11- 4-49	8371	4780- 4787	Yegua sd; Eoc	P 48	44.8
Victoria	McFaddin, E.	Union Prod. Co. et al's McFaddin et al 10-A, in NE corner C. O. Edwards Sur.	11-22-49	6415	5625- 5627		F 121; 1/2"	36.1
Victoria	Victoria-Deep	Scurlock Oil Co's Meta Buckert 1, 330 fr ne&sel of W¼ Blk 4, Rge 2, East Below Twn Trs, Victoria Four Lge Gr.	11-14-49	5315	5267- 5274		F 153; 11/64"	40
		TEXAS—District 2 (MIDDLE GULF)—Oil Field Extension						
Victoria	Coletto Creek	Rock Hill Oil Co's C. P. Marthiljohni, Jr. 2, 330 fr nwl 450 fr wl of 145.92-ac Lse, R. Manchola Gr, ⅔ mi s-sw extension.	11-15-49	5023	4341- 4343	Frio sd; Olig	F 108; 1/8"	
		TEXAS—District 2 (MIDDLE GULF)—New Distillate Field						
Goliad	Angel City	Stanolind O&G Co's J. Bluhm 1, 467 fr w&sel of 215-ac Lse, Maria de Jesus Sur, 12 mi nw Goliad.	11- 5-49	9015	8042- 8050	Slick-Wilcox sd; Eoc	F 67; 2.9 mln; 7/64"	51
		TEXAS—District 2 (MIDDLE GULF)—Distillate Field Extension						
Lavaca	Yoakum	Sam G. Harrison's Linebarger Unit 1, 2300 fr n'ly nwl 3800 fr w'ly swl Patrick May Sur, ⅔ mi e-ne extension.	10-15-49	8664	8660- 8663		No gge	
		TEXAS—District 2 (MIDDLE GULF)—New Gas Fields						
Bee		Hewit & Dougherty's K. D. Roche 1-B, 1350 fr el 1200 fr wl 2400 fr nl of most e'ly Timothy Hart Sur, 6 mi ne Skidmore.	11- 5-49	5420	4236- 4247		50 mln; open	
Lavaca	Seclusion	Sterling O&R Co's Lafey Miller 1, 1700 fr n'ly nl 1400 fr el A. S. White Sur, 4½ mi sw Provident City fld.	11-14-49	6600	6080- 6090		3.3 mln; 3/4"	
		TEXAS—District 3 (UPPER GULF)—New Oil Fields						
Austin		McCarthy O&G Corp's Leo Schiller at al 1-A, 1170 fr ne'ly nel 832 fr w'ly sel Adam Kuykendall Sur, 4½ mi e New Ulm.	11-28-49	10206	9048- 9058 9467- 9485	Wilcox sd; Eoc Wilcox sd; Eoc	F 300; 1/4" F 450; 3/4"	41.1 39
Polk		Wesley West & J. M. West, Jr.'s West Securities Co. & Tex. Long Leaf Lbr. Co. 1, 660 fr ne&nwl of 564.48-ac Lse, A. Viesca Lge, 1 mi e Copeland Creek fld.	11- 8-49	7550	3342- 3352	Jackson series sd; Eoc	F 36; 5/32"	32.3
		TEXAS—District 3 (UPPER GULF)—New Oil Pays						
Brazoria	W. Columbia-New	The Texas Co's J. G. Phillips et al 37, 330 fr swl 745 fr w extremity of sl of 323.5-ac Lse, Geo. Tennille Lge.	11-22-49	6531	6180- 6210		F 181; 3/4"	29.7
Liberty	Hull	John W. Mecom's A. Merchant Est. 1-D, 800 fr sl 1650 fr wl H&TC Sur 194, ½ mi nw of prod.	11- 7-49	9068	8170- 8178		F 200; 1/8"	30.4
Liberty	Liberty, S.	Floyd L. Karsten's Rose Stelzig Unit, 175 fr sl 3070 fr el East town of Liberty Lge.	10-25-49	7561	6808- 6825 6920- 6938		F 247; 3/32" F 242; 3/32"	36.4 36.8
		TEXAS—District 3 (UPPER GULF)—Oil Field Extension						
Matagorda	Old Ocean	J. S. Abercrombie Co's Tide-Harding 5, 847 fr nwl 600 fr swl Battle, Berry & Williams Lge, ¾ mi sw extension.	10- 1-49	11145	10130-10133	Frio sd; Olig	F 71; 1/4"	37
		TEXAS—District 3 (UPPER GULF)—New Distillate Fields						
Austin		McCarthy O&G Corp's Adolph Weige 1, 168-ac Lse, James Tylee Sur, 1 mi n New Ulm fld.	11-28-49	11071	9668- 9690		F 45; 9 mln; open	53.2
Colorado		The Chicago Corp's John Drlik 1, 2500 fr sel 4150 fr swl Sam Kennelly Sur, 1 mi nw Garwood.	11-18-49	10080	6796- 6800		F 60; 3.5 mln; 1/4"	56.1
		TEXAS—District 4 (LOWER GULF-SW.)—New Oil Fields						
Duval		Jergins Oil Co's Albert Martin, Tr. 1, 330 n&e fr NWC of Jim Hogg Co, Blk 171, GC&SF Sur, 5 mi nw Hebbronville.	11-30-49	3217	3057- 3068	U. Loma Novia sd; Eoc	F 94; 1/4"	40.1
Hidalgo	Santa Fe, S.	Humble O&R Co's Santa Fe Ranch 5, 24,967 s 5733 e fr NWC San Salvador Del Tule Gr., 3½ mi s Santa Fe fld.	11- 8-49	10125	7722- 7728	Frio sd; Olig	F 73; 3/32"	42
Nueces	"Cement"	Henshaw Bros. & O. R. Mitchell's J. E. Humble 1, 990 fr sl 1400 fr el Sect. 45, Geo. H. Paul Sbdn of Driscoll Rch, se of Minnie Bock fld.	8-15-49	7064	6620- 6628		P 37; 18 wtr	39.5
Nueces	Rand Morgan.	Rand Morgan's Fee 1-M, 330 fr nl 1175 fr wl Blk 3, Richard King Fm Lots, 8 mi nw Agua Dulce.	10-15-49	5425	5392- 5394	Frio sd; Olig	F 57; 3/4"	47
		TEXAS—District 4 (LOWER GULF-SW.)—New Oil Pay						
Brooks	Palo Blanco	W. H. Holland & N. B. Hunt's Alexander 1, 330 fr nl 1660 fr el of 400-ac Lse.	11- 7-49	3659	2990- 2997		F 76; 1/4"	31.5
		TEXAS—District 4 (LOWER GULF-SW.)—Oil Field Extension						
Duval	Rowden	Humble O&R Co's James R. Dougherty 4-G, 2650 fr sl 950 fr el BS&F Sur 511, ¾ mi se extension.	11-18-49	2219	2195- 2219	Basal Cole sd; Eoc	F 184; 1/4"	
		TEXAS—District 4 (LOWER GULF-SW.)—New Distillate Field						
Aransas	Mud Flats	Geo. W. Graham's Margaret E. Davis 1, 660 fr se&swl Lot 7, Blk 48, Resbdn of Sixth Addn. of Taft Fm Lds.	11-29-49	9269	9251- 9254	Frio sd; Olig	F 192; 2.4 mln; 7/16"	52
		TEXAS—District 4 (LOWER GULF-SW.)—New Distillate Pays						
Nueces	Mustang Island	The Atlantic Rfg. Co's State Tr. 429-I, 660 fr nwl 1980 fr nel State Tr. 429, ½ mi fr prod.	11-15-49	7917	7700- 7730		F 36; 3.8 mln; 1/4"	
Nueces	Mustang Island	The Atlantic Rfg. Co's State Tr. 430-I 660 fr sw&nwl State Tr. 430, ½ mi n prod.	9- 1-49	7893	6818- 6868		F 23; 1.7 mln; 1/4"	
		TEXAS—District 4 (LOWER GULF-SW.)—New Gas Pay						
Starr	Flores	Baldridge & King, Inc's State-Slick 1-A, 660 n 1320 w fr NEC Porc. 41, Sur 885.	10-13-49	6736	6339- 6351		16.8 mln; open	
		TEXAS—District 5 (EAST CENTRAL)—New Gas Pay						
Freestone	Steward's Mill	Carter-Gragg Oil Co's C. B. Robinson 1, 800 fr wl 500 fr sl of 291-ac Tr. James James Hrs Sur.	11-10-49	8150	7600- 7645	Pettit li; L. Cre	2.8 mln; 7/32"	
		TEXAS—District 6 (NORTHEAST)—New Oil Field						
Anderson	"Tennessee Colony"	Continental Oil Co's Royall Nat'l Bank 1, 1400 fr wl 830 fr nl A. G. Monroe Sur, ½ mi se Tennessee Colony.	11-19-49	10182	8865- 8885 8965- 8990	U. Rodessa li; L. Cre L. Rodessa li; L. Cre.	F 109; 1/2" F 368; 2.8 mln; open	45.5 57
		TEXAS—District 7-B (N. CENTRAL)—New Oil Fields						
Callahan		Bert, Wilkinson, Evans & Miesse's Murray Harris 1, 250 fr sl 150 fr wl Sect. 114, BBB&C Sur, 4 mi n Baird.	11-26-49	1287	1284- 1287		P 3	40
Callahan	"Mikapam"	B. F. Phillips' R. D. Williams 2, 330 fr n&wl Sect. 139, University Lds Sur, 5 mi nw Putnam.	11-20-49	4109	2140- 2153		F 141; 1/2"	41
Callahan		Woods Drlg. Co's Mrs. Ben Yarbrough 1, 450 fr nl 330 fr el B. Ferguson Sur 748, 2 mi s Coleman.	11-17-49	2298	2289- 2296		P 16	44

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian: U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.



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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in November, 1949

Also Important Extensions to Established Fields

(CONTINUED)

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
Fisher		A. G. Hill & Walter Duncan's W. P. Bomar 1, 2330 fr el 330 fr sl T. H. Cosby Sur 315, 3 mi e Roby.	11- 4-49	3580	3558- 3580	Cook sd; Penn	P 176; 70 wtr	42.3
Jones		Walter Duncan & A. G. Hill's Mrs. Bettie Burleson 1, 330 fr el 990 fr sl Blk 12, J. W. McKissick Sur 208, 7 mi sw Anson.	11-19-49	3615	3463- 3490	Canyon sd; Penn	P 24	41
Jones		S. C. Herring Drlg. Co's C. P. Amerson 1, 330 fr sl 2150 fr wl Sect. 117, Blk 1, BBB&C Sur, 11 mi w Stamford.	11-11-49	3073	3062- 3073	King li; Penn	P 5; 5 wtr	40
Jones		Stewart & Fox' Wilkinson 1, 990 fr nl 330 fr wl Sect. 22, Blk 19, T&P Sur, 3 mi n Trent.	11- 8-49	2577	2551- 2554	Noodle Creek li; Penn	P 5; 3 wtr	41
Shackelford		Clyde Nelson's W. D. Baker 2, 990 fr nl 110 fr wl Sect. 216, ETRR Sur, 3 mi se Lueders.	11- 5-49	1717	1715- 1717		P 16	39.9
Shackelford		West Central Drlg. Co's D. Manley 1, 1650 fr nl 330 fr el Sect. 25, Blk 14, T&P Sur, 15 mi w-sw Albany.	11-27-49	1630	1618- 1630		P 10	40
Stephens		Connally-Thorton et al's H. W. Hart 1, 1650 fr nl 990 fr wl Sect. 2065, TF&L Sur, 7 mi se Breckenridge.	11-29-49	3332	1950- 1966		F 41; 1/4"	42
Stephens		McElroy Ranch Co's D. G. Stover 1-B, 579 fr nl 453 fr el of mst w'ly part Sect. 3, Blk 8, T&P Sur, 5 mi nw Breckenridge.	11-19-49	4748	4600- 4612	Mississippi li; Miss	F 350; 11/64"	41.1
Stephens		Wasson Oil Co's W. P. Smith 1, 330 fr el 1563 fr sl of NE1/4 Sect. 14, Blk 2, SPRR Sur.	11-20-49	3315	3276- 3315	Caddo li; Penn	P 5; 5 wtr	....
Taylor		Sojourner Drlg. Co's W. T. Maddox 1, 1031 fr nl 1650 fr el Sect. 3, Blk 18, T&P Sur, 3 mi s Merkel.	11-20-49	3457	3217- 3219	Pennsylvanian	P 65; 42 wtr	38
Throckmorton		Rock Hill Oil Co's Tom Morrison 1, 1400 fr nl 2706 fr el Sect. 1614, TE&L Sur, 8 mi s Throckmorton.	11-24-49	4682	3566- 3576	Strawn sd; Penn	P 76	40.1
		TEXAS—District 7-B (N. CENTRAL)—New Gas Field						
Coleman		D. L. Riley's P. J. Reeves 1, 3950 fr wl 1850 fr sl B. Ferguson Sur 748, 3 mi s Coleman.	11- 4-49	2202	2196- 2202		2.5 mln	....
		TEXAS—District 7-C (W. CENTRAL)—New Oil Fields						
Runnels		William Hamm Jr.'s S. L. McNay 1, 4419 fr swl 2227 fr sel Jose Marea Garcia Sur 299, 1¼ mi w Wingate fld.	11- 3-49	5330	5309- 5319	Strawn sd; Penn	F 146; 8/16"	45
Runnels		Rambo, Stephens & T. W. Murray's W. Stephens 1, 330 fr n&el of S½ of NW¼ Sect. 81, CTRR Sur, 1½ mi w Winters, N. fld.	11-25-49	4520	4513- 4517	Strawn sd; Penn	F 1652; ¾"	47
		TEXAS—District 7-C (W. CENTRAL)—New Oil Pays						
Coke	Lygay	A. G. Hill's Ralph Harris Est. 6, Sect. 521, Valentine Homann Sur	11-12-49	6875	6484- 6508	Pennsylvania Reef li; Penn	P 82	42.3
Runnels	Winters	Humble O&R Co's Bud Herndon 1, 3320 fr nl 467 fr sl B. W. Taylor Sur 2	10-26-49	4674	3938- 3944	L. Canyon li; Penn	F 167; ½"	45.6
		TEXAS—District 7-C (W. CENTRAL)—Oil Field Extensions						
Coke	Davenport	Humble O&R Co's Sallie Odom et al 3, 1250 fr nl 1380 fr el Seforiano De La Garza Sur 304, ⅔ mi n extension.	11-19-49	5541	5520- 5525	Strawn sd; Penn	P 37; 62 wtr	44.4
Upton	Pegasus	Republic Nat'l Gas Co's V. J. Powell 1, 660 fr n&wl Sect. 44, Blk 40, T-4-S, T&P Sur, 2¾ mi se extension.	10-14-49	13125	12945-13019	Ellenburger dolo; Ord	F 639; ¾"	53.1
		TEXAS—District 7-C (W. CENTRAL)—New Gas Field						
Sutton		Shell Oil Co's S. B. Roberts 1, 827 fr nl 398 fr wl Sect. 7, Blk 7, TW&NG Sur, 35 mi se Sonora.	9-25-49	4653	3406- 3475	Strawn li; Penn	0.2 mln; ¼"	....
		TEXAS—District 8 (WEST)—New Oil Fields						
Gaines		The Texas Co's E. D. Harris 1, 660 fr n&el Sect. 17, Blk A-22, PSL Sur, 3 mi e Flanagan fld.	10-29-49	7520	5965- 5980	Glorietta li; Perm	P 42	31.9
Pecos		C. S. Messinger's Iowa Realty Trust 1, 330 fr se&nel NE½ W¼ Sect. 74, Blk 10, H&GN Sur, ½ mi e Masterson fld.	11-20-49	1761	1708- 1761	Permian	F 20; open	33
		TEXAS—District 8 (WEST)—New Oil Pays						
Gaines	Flanagan	Shell Oil Co's W. L. Hawkins 1, (OWWO), 1983 fr nl 665 fr el Sect. 8, Blk A-23, PSL Sur.	10-30-49	12174	10300-10380	Devonian li; Devo	F 1391; 8/16"	33.7
Scurry	Sharon Ridge	D&R Oil Co's W. F. Burney 17, (OWWO), 1980 fr nl 2130 fr wl Sect. 143, Blk 97, H&TC Sur.	11-10-49	8238	3004- 3110	Clear Fork li; Perm	P 61; 6 wtr	30
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Andrews	Dollarhide	Cities Service Oil Co's Cowden 1-G, 660 fr s&el Sect. 15, Blk A-52, PSL Sur, extends Clear Fork ½ mi west.	11- 1-49	7830	6535- 6645	Clear Fork li; Perm	F 548; 24/64"	38.5
Cochran	Levelland	Lion Oil Co's F. O. Masten 1, 440 fr n&el Lab 12, Lge 132, Carson CSL Sur, ¾ mi s extension.	10-31-49	5033	4995- 5030	San Andres li; Perm	F 202; 24/64"	31.8
Crane	Tucker	George T. Abell's Texas American Syndicate 1, 330 fr ne&nwl of S ¾-ac of Sect. 25, Blk 1, H&TC Sur, ½ mi s extension.	11- 7-49	5905	5780- 5905	Simpson li; Ord	F 354; ½"	41
Gaines	Flanagan-Clear Fork	Shell Oil Co's Selma Andrews et al 1, 660 fr s&wl Sect. 2, Blk A-23, PSL Sur, ⅝ mi ne extension.	11-18-49	12580	7150- 7224	Clear Fork li; Perm	P 133; 75 wtr	38.5
Scurry	Diamond-M	Newman Bros., Alaska Steamship Co. & Calvert Corp's H. H. Eiland 1, 467 fr s&wl of N½ Sect. 202, Blk 97, H&TC Sur, 2 mi ne extension.	10-16-49	6767	6605- 6760	Canyon Reef li; Penn	F 833; ¼"	43.5
Scurry	Kelly-Canyon	Nelson Bunker Hunt's W. J. Coonrod 1, 467 fr n&el SW 83-ac of Sect. 251, Blk 97, H&TC Sur, 1¼ mi n extension.	11-27-49	6655	6538- 6552	Canyon Reef li; Penn	F 496; ¼"	44
Scurry	Kelly-Canyon	Newman Bros., Alaska Steamship Co. & Calvert Corp's Hugh Boren 1, 467 fr s&el NE¼ Sect. 247, Blk 97, H&TC Sur, 1¼ mi nw extension.	11-20-49	6796	6685- 6795	Canyon Reef li; Penn	F 649; ⅜"	44.2
Scurry	Kelly-Canyon	S. B. Roberts et al's Burl H. Lewis 1, 467 fr s&wl of SE¼ of Sect. 246, Blk 97, H&TC Sur, 2¾ mi nw extension.	11- 4-49	6868	6838- 6868	Canyon Reef li; Penn	F 611; ½"	42.1
Winkler	Flying-W	Gulf Oil Corp's Keystone 146-D, 1980 fr el 660 fr sl Sect. 24, Blk A 57, PSL Sur, ½ mi ne extension.	11-21-49	11877	9605- 9755	Devonian li; Devo	F 210; ½"	37.5
		TEXAS—District 9 (NORTH)—New Oil Fields						
Archer		J. J. Lynn's A. J. DeMoss 1, 330 fr n&wl Lot 18, Blk 5, Clark & Plumb Sur, 3½ mi se King-Wilson fld.	11-18-49	3608	3607- 3608	Strawn sd; Penn	F 302; ¼"	42
Clay		Akin & Dimock's G. W. Chapman 1, 330 fr el 1350 fr sl Blk 18, Hopkins CSL Sur, 4 mi e Acme fld.	11-11-49	4725	4651- 4660	Vogtsberger sd; Penn	P 72; 20 wtr	42
Clay		Wilder & Underwood's J. B. Dunn 1-A, 150 fr sl 1300 fr wl of N½ Blk 24, Byers Bros. Sbdn, 2 mi n Petrolia fld.	10-29-49	1862	1858- 1862		P 45	....
Denton		C. B. Slemp's Gibson Est. 1, 550 fr el 750 fr sl O. Wilcox Sur, 4 mi nw Bolivar	11- 1-49	1689	1685- 1689		P 80	26
Wichita		Southern Pet. Exploration, Inc. & Chas. E. Morrison's R. L. Kempner 1, 330 fr n&el of W½ of NE¼ Sect. 80, Blk 5, SPRR Sur, 3 mi w kempner fld.	11-14-49	4330	4305- 4328	Caddo li; Penn	P 122; 20 wtr	44
		TEXAS—District 9 (NORTH)—New Oil Pay						
Montague	Thomas	Harvey Drlg. Co. & Burk Rylty Co's Fred Wines 1, 330 fr s&wl Blk 95, Kaufman CSL Sur.	11- 3-49	3010	2999- 3010	Strawn sd; Penn	P 70	33
		TEXAS—District 9 (NORTH)—Oil Field Extensions						
Jack	Cherryhomes	G. E. Kadane & Sons' T. N. Rhodes 1, 1168 fr sl 938 fr wl MEP&PRR Sur, 1 mi sw extension.	11-22-49	4624	4610- 4624	Bend cgl; Penn	P 135	41
Jack	Joplin	Russell Maguire's H. L. Roper 1, 330 fr s&el Blk 21, Lge 2, Henderson CSL Sur, 1 mi nw extension.	11-14-49	4896	4592- 4609	Bend cgl; Penn	F 152; ¼"	42
Montague	Caraway-Bundy	Konrad Sztykgold's R. S. Whitecotton 1, 467 fr sel 647 fr nel H. Ravenstone Sur, ¾ mi nw extension.	11-25-49	6365	6225- 6227	Bend cgl; Penn	F 894; ⅜"	42
Young	Young Co. Reg.	The British American Oil Prod. Co's G. H. Roach 2-B, 330 fr el 990 fr sl Sect 304, TE&L Sur, 1½ mi w extension.	11-25-49	4991	4885- 4991	Mississippi li; Miss	F 1344; 12/64"	40.7
		WEST VIRGINIA—New Gas Field						
Wood		Clarence W. Meadows, Tr.'s C. A. Barnette 1, Steele district	11-20-49	5360	5344- 5360	Oriskany sd; Devo	5 mln	....
		WYOMING—New Oil Field						
Weston		Esperado Mining Co's State 1, SE SE SW 16-45n-67w	11- 1-49	7720	7280- 7300	Newcastle sd; U. Cre	F 90	....
		WYOMING—Oil Field Extension						
Weston	Lodge Pole	Bay Pet. Co's Long 1, C NE NE 8-44n-66w, ¾ mi nw extension	11-15-49	6820	6774- 6780	Dakota sd; U. Cre	P 15	....
		WYOMING—New Gas Field						
Sweetwater	Salt Wells	Husky Rfg. Co. & Continental Oil Co's Unit 1, C SW NW 11-14n-103w	11- 2-49	7214	6262- 6286	Dakota sd; U. Cre	12.6 mln 8/16"	....

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formation abbreviated thus: Plio, Pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hour rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

By J. E. KASTROP
Gulf Coast District Editor

Humble's Block Deflector Speeds Trip Time

FIGURE 1. Looking down on the deflected block as it is lowered past the drill pipe held in the center of the derrick. The derrickman controls the upper racking arm in guiding the pipe into and out of the elevators.

INCREASING efficiency of rotary drilling methods and reducing occupational fatigue are two primary goals of Humble Oil & Refining Company's drilling equipment research and development program now in its fourth year. Of the many innovations under investigation and improvement by the Petroleum Engineering division on Humble's "automatic" Rig 30, a new device, known as a traveling block deflector, has contributed a substantial share toward reducing round-trip time.

THE TRAVELING BLOCK deflector, unique in drilling equipment, recently emerged from Humble's aggressive equipment research and development program. Result of this new device on Rig 30 has been a reduction in round-trip time of 25 percent. The block deflector alone accounts for saving one hour per round trip on a 10,000-foot well.

Drilling time studies show that of the total time required to drill wells in the Gulf Coast, about 13 percent was spent in making round trips. Included in this round-trip time is that time during which no productive work is being accomplished as far as pulling or lowering the drill stem is concerned. There is some "unproductive" time consumed in waiting for the empty traveling block to descend from a point above the monkey board to the floor when coming out of the hole. Additional "unproductive" time is required for the empty block to ascend from the floor to the monkey board when going in the hole. It was upon this particular segment of round-trip time that a reduction was effected.

Since the block deflector was perfected to its present state, time saved on round trips has amounted to about 15 seconds or more per stand of pipe when making the trip in the well, plus an additional 15 seconds saving per stand when coming out of the hole. On a 10,000-foot well, the saving in time for a complete round trip made under normal conditions wherein no unusual trouble is encountered by virtue of hole conditions, etc., will amount to about one hour. This one-hour reduction can be attributed directly to the block deflector.

Limited Application

It is important to note that the block deflector can be used only in conjunction with additional means to handle a single stand of pipe other than the traveling block. On Rig 30, an auxiliary elevator operating with an automatic pipe racker[1] lifts a thribble of pipe from the power tongs (once the joint is broken) to an elevated pipe rack platform. When going in the hole, this automatic pipe racker lifts a stand of drill stem from the pipe rack and places it in the grip of the power tongs for further transfer to the make-up position over the rotary. Use of the traveling block is not required in these operations except to carry the load of the entire string of pipe when lifting or lowering the drill stem.

Before the block deflector was installed, there was a period of waiting while the block traveled empty from the monkey board to the floor to pick up the drill stem when coming out of the hole. There was a similar waiting period when the block made its return trip from floor to derrickman to pick up the drill stem and lower it in the hole after a thribble had been added. The block deflector now makes it possible to utilize this former "waiting" time to make up or break out the joint in order that the block can take the load of the drill stem immediately without waiting for the pipe handling procedure.

Four fundamental parts make up the block deflector assembly: (1) a six-inch steel I-beam monorail extending from the first girt up to the crown block; (2) a carriage which travels up and down the monorail; (3) a pneumatic power cylinder; and (4) an adjustable steel cable. The monorail is mounted to the derrick on the opposite side from the monkey board by tripod braces located at, and bolted directly to, each girt from the crown block down to the monkey board level. From this point down to the first girt, the monorail follows a vertical path which at the base is offset about five feet

from the derrick axis. The block can be deflected a distance of three feet from this derrick axis line. As the block travels upward, this three-foot deflection is maintained until it reaches the monkey board, where it tends in slightly toward the center of the derrick.

Pulley System

Carriage of the deflector assembly rides up and down the monorail on four rollers bolted to its side plates. Two rollers on either side of the carriage roll on the inner face of the I-beam flange. These side plates support four pulleys, one pair mounted above a matching pair as shown in Figure 2. The illustration also shows two pulleys, independent of each other, hinge-mounted to a singletree arrangement which in turn is hinged to the block by a heavy pin. An additional pair of pulleys is mounted at the lower end of the monorail. A similar pair of pulleys is supported at the top of the derrick to transfer the cable from inside the derrick to the outside.

An air-driven, double-drum hoist was mounted to the derrick between the seventh and eighth girt. Original purpose of this hoist was to provide the necessary force to pull and hold the block off center. It was found, however, that a pneumatic cylinder and piston would serve this purpose to better advantage. For the present, the dual-drum air-hoist serves only as a means of anchoring a pair of flexible steel cables used in the system. It is intended that this air hoist be used for other project developments.

From the point of anchorage at the air hoist, these dual cables extend downward to and thread through both pulleys mounted on the bottom of the monorail. Direction of each cable is diverted upward and parallel to the monorail, led through the lower pair of pulleys in the carriage, then through the pulleys mounted on the traveling block, back to the upper pair of carriage pulleys and on up to the two pulleys mounted at the top of the derrick. Both cables pass over these two pulleys and extend down the outside of the derrick for a short distance where they terminate in a singletree arrangement which connects to a single cable. This large line extends down parallel to the derrick and connects to the piston rod of a pneumatic power cylinder anchored at its lower end to the substructure. Stuffing box and upper end of the cylinder are supported by the first girt.

By pressurizing the pneumatic cylinder, the piston is driven downward, thereby tightening the two cables in the pulley system. As these cables tighten, the traveling block is drawn closer to the monorail carriage. Total weight of the traveling block, hook, bails and elevator

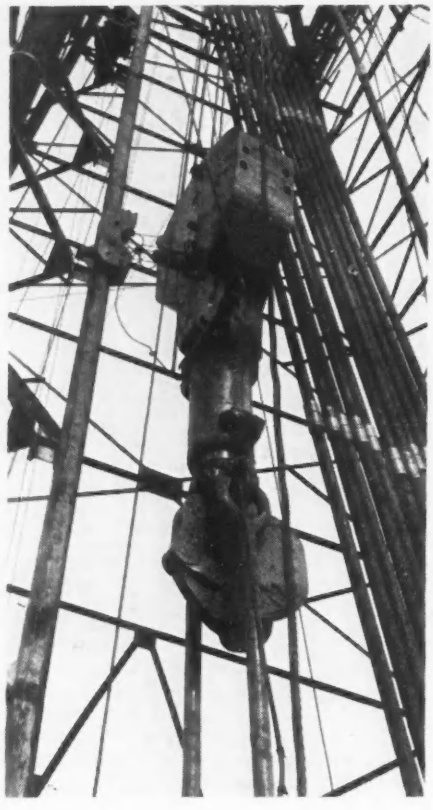

FIGURE 2. Closeup of carriage assembly and pulley arrangement on the traveling block. These twin cables threaded through this pulley system do not move up and down with the block. Enough tension is placed on these cables to pull the block from center.

is about 18,200 pounds. Air pressure of approximately 15 pounds per square inch applied to the piston of a five-inch inside-diameter cylinder provides the force necessary to deflect the block and overcome friction losses in the mechanism. Travel of the air piston is little more than six feet.

Deflector Control

A rotary helper controls the block deflector by means of a two-way air valve mounted on a movable triangular frame which also supports a foot pedal air valve to control an experimental automatic elevator latching device. Primary function of the operator in making round trips is to latch and unlatch the elevators by pneumatic power and to control the deflection of the traveling block.

Sequence of events when coming out of the hole with the drill stem begins as the driller sets the automatic slips. When the load of the drill pipe is transferred to the rotary, the operator on the floor unlatches the elevators and at the same time starts deflecting the block. By pressurizing the pneumatic cylinder, tension is placed in the twin cables to pull the block away from center. At this point, the driller slacks off on the brake without any delay and permits the block to descend.

During this time, remote control power tongs and the automatic pipe racker go into action. Tongs break out the joint and the pipe is completely unscrewed. While maintaining a grip on the tool joint, the upper power tongs support the thribble of pipe and swing it toward an elevated pipe rack. The lower racking arm latches on the pipe with a hydraulic gripping device which lifts the pipe from the power tongs and guides it to the racking platform. The power tong operator also controls the lower racking arm, while the derrickman operates the upper racking arm to guide the pipe in and out of the elevators.

While pipe racking operations are under way the driller lowers the block which is held away from the drill pipe and about three feet off center by the block deflecting mechanism. By the time the block descends to the floor, the tong operator has removed the previous stand of pipe to the pipe rack and the block is returned to center. The rotary helper on the floor coordinates release of the block with the latching operation. As the block swings back into the axis of the derrick, the power-operated elevators automatically latch around the pipe and the driller then pulls another thribble from the hole.

Going in the Hole

Making the trip back in the hole is quite similar in operation to coming out of the hole with the exception that the procedure is reversed. The block is deflected on the return trip up the derrick, during which time the tong operator and derrickman add another stand to the drill stem. Even though the cycle of operations in making round trips is performed at a faster rate with the block deflector, this latter item has met the approval of the drilling crew since their work can be done more leisurely with this assemblage of automatic and semi-automatic equipment as compared with conventional methods of handling pipe.

Humble's Rig 30 was selected for this development work because it was typical of the company's modern, heavy-duty steam rotary rigs located in a field which for several reasons was convenient for experimentation of this nature. Its crew is typical of those found on other Humble rigs.

Since the equipment development and research program was begun by the Petroleum Engineering division in 1945, a long list of new and unusual devices not common to the oil field has emerged. Results of all new equipment developments made in the past four years cannot be appraised at this early date in dollars and cents. It is doubtful if their full value

can ever be calculated on the books. Immediate savings in drilling time have been estimated for one particular area in the Gulf Coast. On a 10,000-foot well, savings directly responsible to these new pieces of drilling equipment total approximately 2½ days per well with rig costs amounting to about $1500 per day.

Other important results, yet more difficult to estimate, are the effects of increased safety of operations and added life to drilling equipment due to stepped-up efficiencies. Of considerable value to the company, too, is higher working efficiency of the individual due to less fatigue.

Many new and revolutionary ideas have been put into practical form, while others are still in the proving stage on Rig 30. What will come from this rotary drilling equipment laboratory next, only time will tell. But, since this program is continuing at a very active pace, industry can look for other unconventional time and labor-saving devices for the drilling rig.

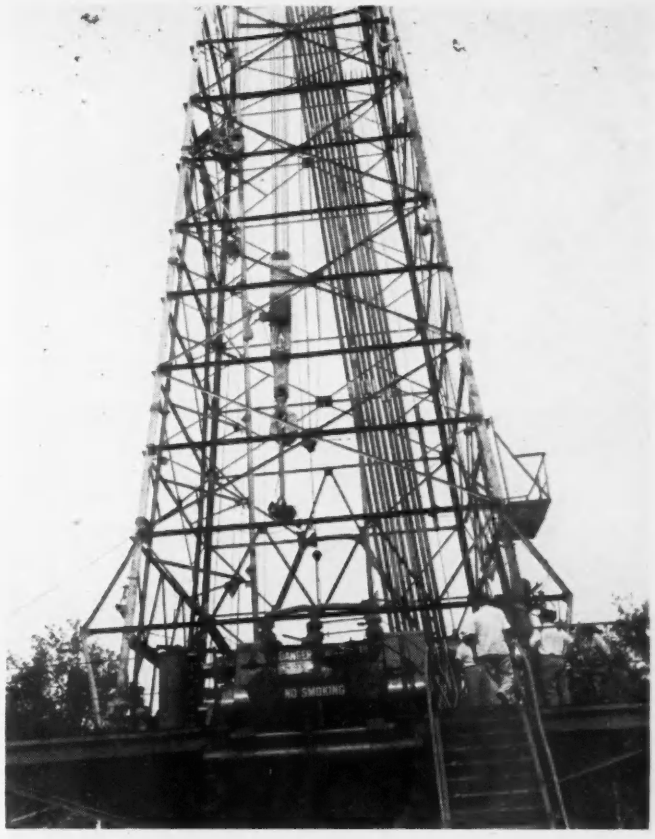

FIGURE 3. The traveling block is held to the left as it descends to pick up the drill stem. A previously disconnected thribble is being placed on the elevated pipe rack by automatic racking equipment.

REFERENCE

[1] Kastrop, J. E., Remote Control Power Tongs and Pipe Racker Lessen Crew Fatigue. World Oil, Vol. 128, No. 9, p. 76. Jan. 1949.

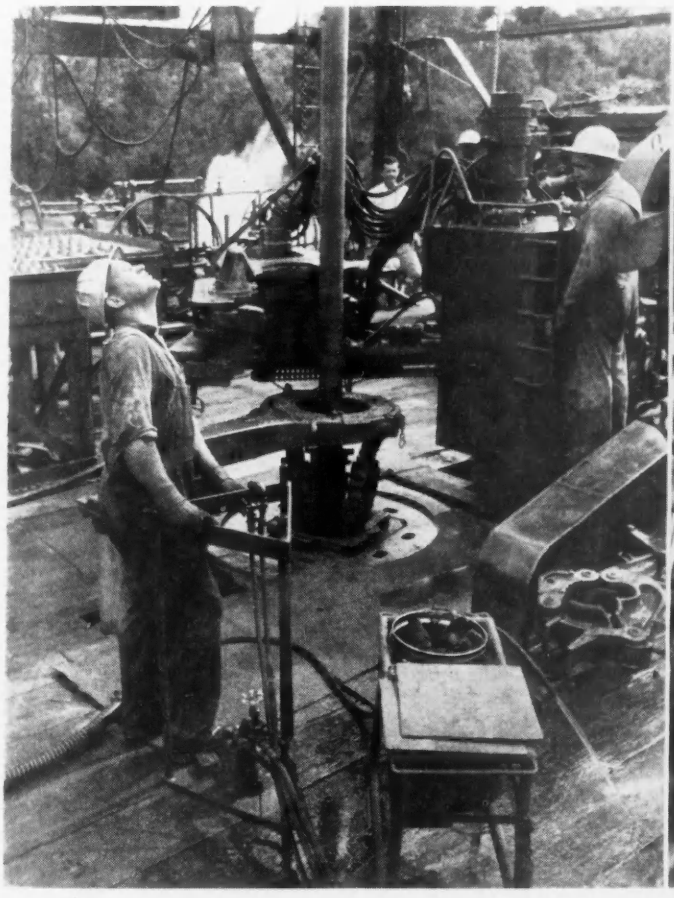

FIGURE 4 (Left). The rotary helper at the controls of the block deflector and air-operated elevator latching device watches as the block approaches the derrickman. When the slips are set, he unlatches the elevator and pulls the block away from the pipe as it is lowered without delay.
FIGURE 5 (Right). Force required to tighten both cables and thereby pull the block away from its hanging position is supplied by this pneumatic cylinder anchored to the derrick substructure.

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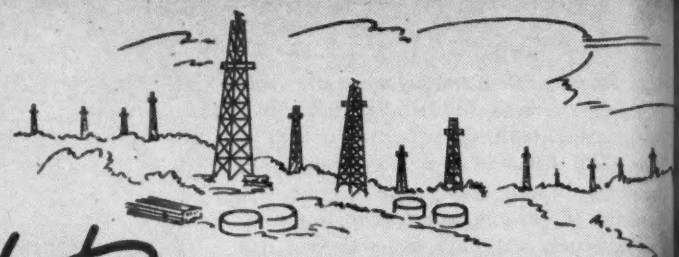

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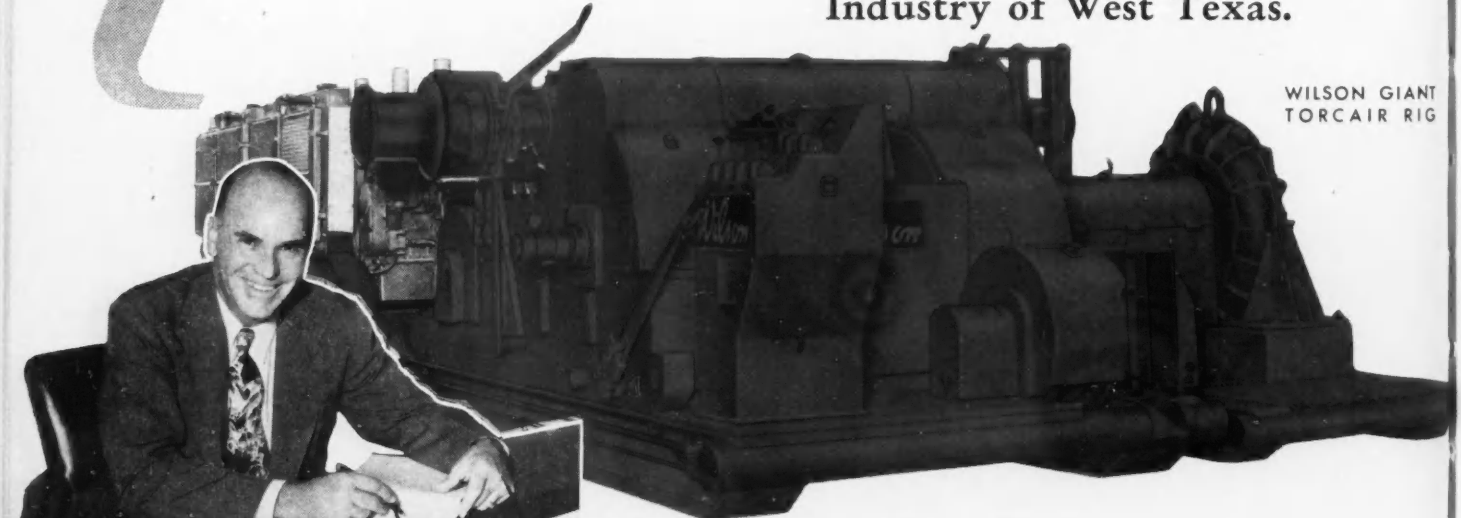

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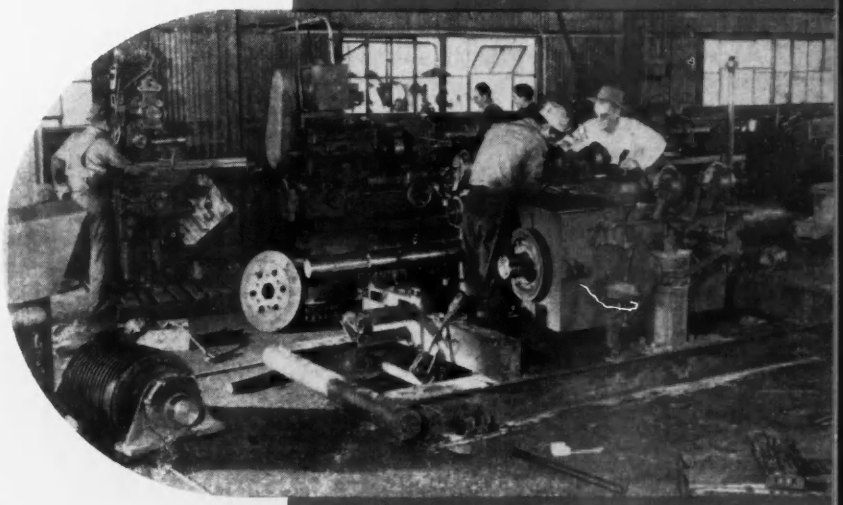

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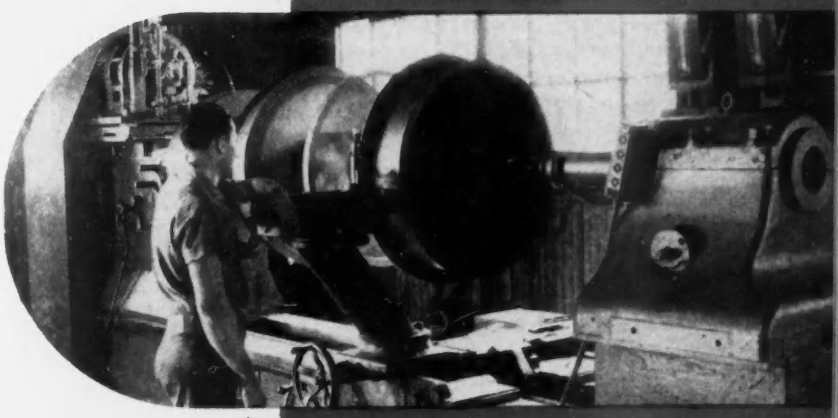

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Well Completion Practices

Part 3 (Of Four)—Well Washing

BY DR. CARROL M. BEESON
Associate Professor of Petroleum Engineering
University of Southern California

BOTH AQUEOUS and non-aqueous well washes are classified in this installment. The various subtypes are discussed with the view of indicating the factors that should be considered in choosing a wash fluid. Literature is cited to show that success in well washing has already been demonstrated from the standpoint of the net effect on a number of wells. Means of increasing the proportion of successful jobs are indicated.

THE first article in this series dealt with "Completions," emphasizing the need for improvements in the completion stage of drilling and producing operations. This involved a discussion of the knowledge needed to make the best choice of materials, tools and techniques, as well as means of acquiring the knowledge.

The second article was concerned with "Completion Muds," mainly from the standpoint of the factors that influence subsequent production. The factor treated in greatest detail was loss of mud, including solid particles, to the pores of formations with permeabilities even below 100 millidarcys. Laboratory data were included.

The previous installment on completion muds and the present article on wash fluids represent a discussion of the more inclusive category, completion fluids. The fourth installment will emphasize "Remedial Work."

Wash fluids were first used to remove completion muds from the well bore, or at least to dilute the muds. Some flushing operations were soon being performed with fluids developed to assist, by chemical action, the mechanical effect of the hydraulic forces involved. With such reactive fluids, a "pickling time" often was allowed. Success along mechanical and chemical lines led to carefully planned washing operations, using wash fluids and tools which were developed for the purpose.

The simplest washing operation is flushing. This is done by displacing the mud with another fluid, which should remove a large part of the fluid mud, some of the gelled mud, and possibly some of the mud cake. More vigorous operations, combining surging and jetting, result from washing with higher fluid velocities. In either case, unless the completion mud is less dense than the flush fluid, a lowering of the pressure exerted on the formations will attend the operation. This may aid in the removal of mud cake from the well walls, due to the influx of formation fluids into the well bore.

A carefully planned wash job should remove production deterrents by dilution, re-dispersion, solution, detergency, chemical action and, unless definitely dangerous, by mechanical action. One main objective is the removal of all materials that may plug liners or screens or reduce the flow of oil from the formation to the well head. Such materials are fluid mud, gelled mud, plaster cake, mud cake, and detritus. In addition, the wash fluid penertating into the formation should not reduce the permeability to oil or gas, but rather should minimize any such effect that may have been caused by the completion mud. These requirements call for careful consideration of washing materials, tools and techniques, as well as timing of the wash job.

Wells should be washed during the completion operation; otherwise, any damage done during completion may become deep seated and more difficult to remedy. The harmful effects that can come from prolonging completion time were discussed in the first article of this series. These same considerations are equally pertinent to washing time, unless it has been shown beyond reasonable doubt that they do not apply to the particular wash materials and tools involved.

Expense is incurred in sampling the well bore and surrounding formations for the presence of plugging material. However, this expedient may be advisable, even during the completion stage, under one of the following circumstances:

1. The well is among the first drilled in the field.
2. The formation test is below expectations.
3. It is expected that later remedial work will be benefited by a comparison between samples taken early in the life of the well and those taken at a later date.

Classification of Wash Fluids

Wash fluids in use today may be divided into the two main types, aqueous and non-aqueous. They may be further subdivided, as shown below.

I. Aqueous Wash Fluids
  A. Fresh water
  B. Saline solutions
    1. Sodium chloride (salt) solutions
    2. Calcium chloride solutions
    3. Miscellaneous salt solutions
    4. Formation water
    5. Synthetic formation water
    6. Sea water
  C. Dispersants
    1. Quebracho or equivalent
      a. With lye
      b. With Polyphosphates
    2. Polyphosphates
    3. Surface-active agents
      a. Wetting agents
      b. Detergents
  D. Acids
    (usually contain inhibitors and surface-active agents)
    1. "Wash" (hydrochloric) acid
    2. "Mud" (hydrofluoric) acid
    3. Miscellaneous acids
    4. Acid salts

II. Non-Aqueous Wash Fluids
  (may contain surface-active agents)
  A. Crude oil
  B. Refined oil
  C. Oil-water solvents

During the early stages in the development of well washing, a fluid often

was used for one purpose only. The present trend seems to be in the direction of combining many materials for accomplishing all of the actions desired. Of course, all deterrents to production should be removed as completely as possible from the well bore, without damaging the formations. These considerations might be kept in mind throughout the following discussion of the fluids listed in the classification.

Aqueous Wash Fluids

Fresh Water

Water was first used simply to flush the well bore in the pay zone. Naturally the water was fresh whenever this type was most readily available. However, the use of fresh water has been shown[1] to be hazardous, as penetration into the formation may seriously reduce permeability, due to hydration and resulting deflocculation of clays intermingled with sands.

Saline Solutions

Early well washing was done with a brine in those cases where a brine was more available than fresh water, for example, formation water or sea water. More recently, saline solutions have been used expressly to avoid damage to subsequent production. Waters prepared by dissolving sodium chloride in fresh water have been used for this purpose, although experimental investigations have indicated the hazard involved. For example, soil technologists[2] found that contacting soil samples with solutions containing high sodium-calcium ratios resulted in subsequent permeabilities to fresher water which were considerably lower than the original permeabilities to fresher water.

This hazard has been obviated by preparing a solution similar to the formation water, or at least with the proper sodium-calcium ratio. In some cases, calcium chloride was the only salt present in the wash fluid in appreciable quantity. Likewise bicarbonates have been used, as well as salts which release gases for purpose of agitation.

The apparent hardening of certain mud cakes under the influence of salt led many to abandon saline washes, or to add chemicals to counteract the effect.

Dispersants

Chemicals used in thinning muds were considered at an early date as logical ingredients of wash fluids. The thinning action of such agents as quebracho and the polyphosphates had been ascribed to deflocculation of clays. It was reasonable, therefore, to suppose that a similar action would aid in the re-dispersion and removal of both gelled mud and mud cake. This was a logical development, but it should be borne in mind that any clays present in the formation may also be deflocculated by the penetration of such agents into the pay zone. Providing the main restriction of flow is located in the well bore, the net effect of a deflocculent may be advantageous, despite the damage done to the flow of oil into the well bore.

Surface-active agents were soon added, to help achieve dispersion and removal of harmful material from the well bore. However, the use of these agents was retarded by their cost and by the difficulty encountered in finding suitable wetting agents and detergents which retained their effectiveness when adsorbed by clays.

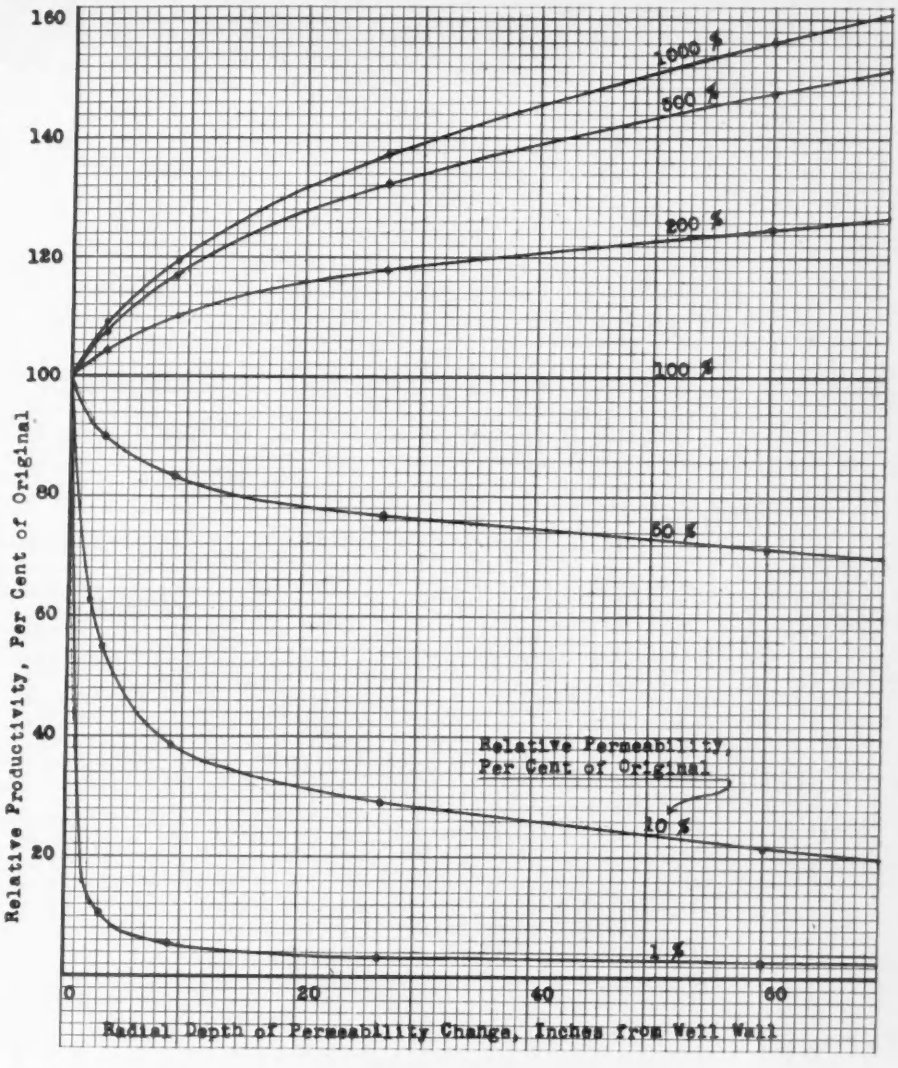

FIGURE 4. Well productivity as affected by permeability change near well bore (uniform sand, six-inch well bore, 500-foot drainage radius).

Acids

As to volume usage, hydrochloric acid is unquestionably the leader among reactive mixtures employed in well washing. This is true for sandstone, as well as limestone or dolomitic formations, since "mud" acid used with sandstone is prepared by mixing a fluoride salt in hydrochloric acid. The mixture forms hydrofluoric acid which dissolves appreciable quantities of clays and sandstones.

Acids used in well washing contain inhibitors for minimizing action on iron or steel. Ordinarily wetting agents and demulsifiers are also present. The former may aid in obtaining good contact between the acid and the material to be dissolved. The presence of demulsifiers should facilitate the subsequent removal of spent acid and reaction products. A refined oil, such as kerosine, is occasionally introduced ahead of the acid to serve as a separating medium between the crude oil and the acid.

Other acids have been used, such as acetic, sulfuric, and phosphoric; as well as the less reactive acid salts, for example, acid sulfate and the acid phosphates. Surface-active agents are also used with these acids and acid salts.

Non-Aqueous Wash Fluids

Oil has had considerable use as a wash fluid. For one thing, the pressure exerted on the formation may be reduced by employing liquids with densities less than that of water. For another, any

detrimental effect of water on the formation might be avoided by the use of oil.

Crude Oil

Oil readily available at the lease naturally was used for washing. Non-sludge forming crudes with low viscosities have been employed with considerable success. Wells drilled with oil-base mud may be especially amenable to such treatment, as the fluid mud, gelled mud, plaster cake, or filter cake often may be readily removed in this way.

Refined Oil

Kerosine, distillate, and other petroleum products have been used in place of crude oil. Although a refined oil usually is more expensive than a crude oil, the refined product should be non-sludge forming and it may have other properties which are more desirable than those of the crude which is available at the lease.

Oil-Water Solvents

Solvents which will dissolve appreciable proportions of both oil and water have the advantage of forming a single liquid phase under the proper conditions. This minimizes the emulsification of oil and water that may occur with other wash fluids. Acids, as well as surface-active agents, have been added to these solvents.

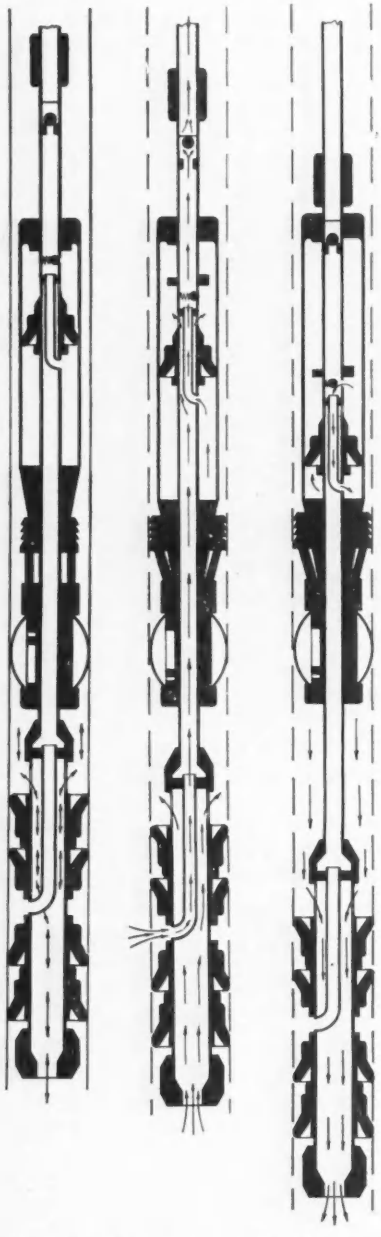

FIGURE 5. Suction washer. *Left*, going in and coming out of hole. *Center*, suction and discharge stroke. Fluid is sucked through perforations between packing cups up through mandrel to space above piston. Fluid below piston discharged to tubing. *Right*, return stroke. In returning to top of stroke, fluid bypasses piston in barrel.

Loss in Productivity Due to Damage Near Well Bore

The second installment in this series included an enumeration of the characteristics of a completion mud which might affect subsequent production. It was pointed out that each of these factors should be considered from the standpoint of their effect upon the flow of oil into the well bore and to the surface. Figure 4 emphasizes the serious decrease in productivity which may attend a decrease in the permeability of even a small portion of the reservoir surrounding the well bore. A well diameter of six inches and a drainage radius of 500 feet have been used in computing the points for the curves. However, large changes may be made in these variables without seriously changing the positions of the curves.

It is apparent from the figure that the portion of the formation immediately surrounding the well bore should be given very careful consideration in all matters dealing with productivity and oil recovery. Not only should completion muds be chosen to minimize any damage to the formation, but well washes should be considered in a similar manner. Indeed careful study may reveal well washes which actually remedy any decrease to formation permeability caused by the completion mud.

Considering the net effect on a number of wells, success in washing has already been demonstrated.[3] The percentage of successful jobs should rise in proportion to the amount of experimental work that is done in the laboratory and in the field.

It is expected, of course, that experiments will be conducted to determine the effect of completion muds on formation characteristics, as well as on the ability of a particular well wash to remedy any damage done by a particular completion mud. Many excellent well-washing tools are already available,[4] and it is reasonable to believe that they will be improved still further and that new ones will be developed. These improvements undoubtedly will cause well washing to assume an ever increasing prominence among the factors which contribute to the maximum recovery of oil.

REFERENCES

[1] Johnston, N., and Beeson, C. M., "Water Permeability of Reservoir Sands," Trans. Amer. Inst. Min. & Met. Engrs. **160**, 43 (1945).

[2] Fireman, M., and Magistad, O. C., "Permeability of Five Western Soils as Affected by the Percentage of Sodium of the Irrigation-Water," Trans. Amer. Geophys. Union **26** (1), 91 (1945).

[3] Cabeen, W. R., and Bemis, E. G., "Field Performance of Sand Control Liners in California," API Paper No. 801-25K, presented at Los Angeles meeting, May 12-13, 1949.

[4] Shea, G. B., "Some Tools and Methods Used in Cleaning Oil Wells in California," U. S. Bu. Mines R. I. 3706, May, 1943.

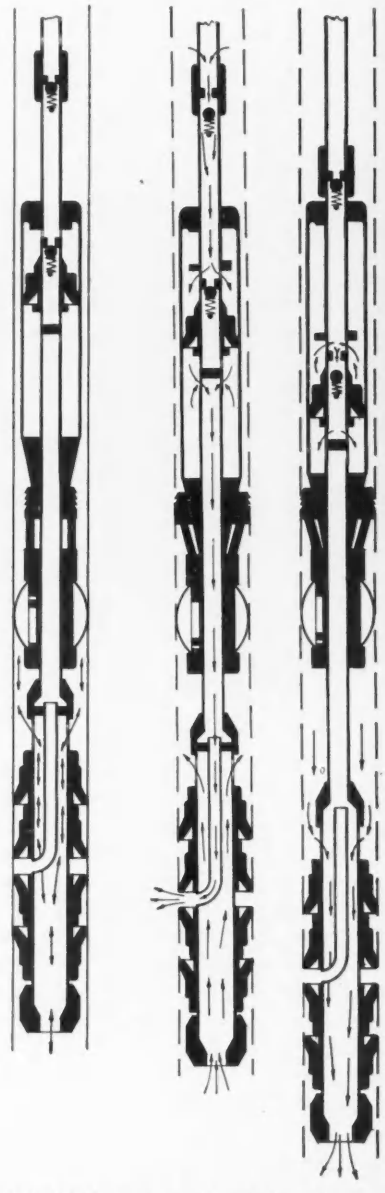

FIGURE 6. Pressure washer. *Left*, going in and coming out of hole. *Center*, pressure washing and intake stroke. Pressure forces fluid below piston through mandrel and out between closely spaced packers through perforations. Fluid is drawn into barrel above piston from tubing. *Right*, in returning to top of stroke, fluid bypasses piston in barrel.

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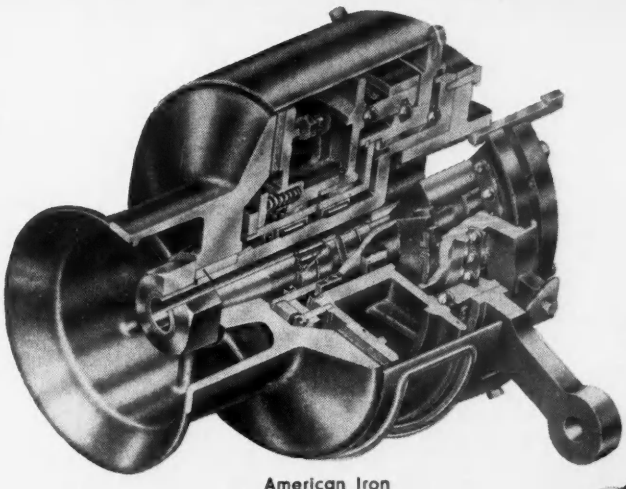

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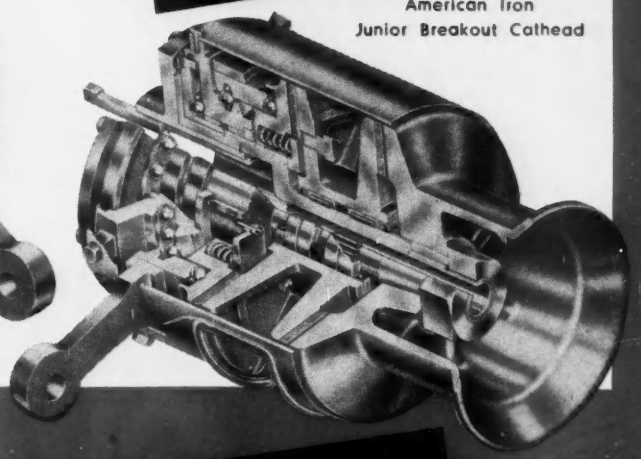

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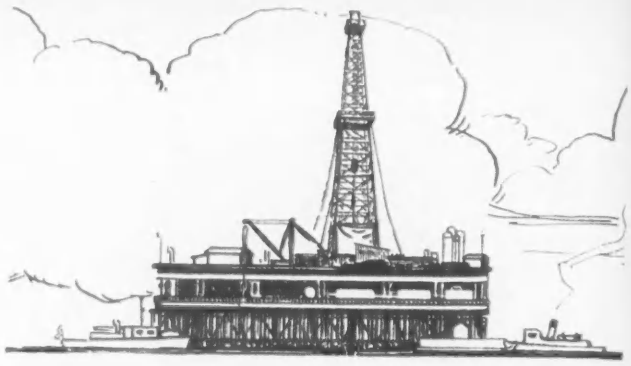
Core Drilling



For Offshore Foundation Data

IN THE GRADUALLY intensifying search for new oil reserves in the Gulf of Mexico, major oil companies are finding themselves beset with a variety of engineering and technological problems not usually present in production and exploration work. One of the biggest problems is the design of pile foundations for the large steel platforms from which many of the wells are being drilled.

IN DESIGNING the foundations for the big offshore platforms, it is important to consider both safety and economy. For safety, the foundation must provide adequate vertical support for the heavy drilling equipment and high operating loads, and adequate horizontal resistance to the destructive forces of wind and waves during tropical storms. For the sake of economy, restraint must be exercised against over-conservative design. Each foot of pile driven beyond a depth that is conservatively efficient produces an extra material cost and also rapidly magnifies the time and cost required for the construction crew and equipment.

Applying the principles of soil mechanics, a method for predetermining the required pile penetration for a particular structure has been adapted to the offshore problem by Greer and McClelland, consulting engineers of Houston. Their procedure includes exploration of the site by means of a deep core boring, shear tests on undisturbed soil samples taken from the core boring, and an analysis of these data with regards to the structure plan.

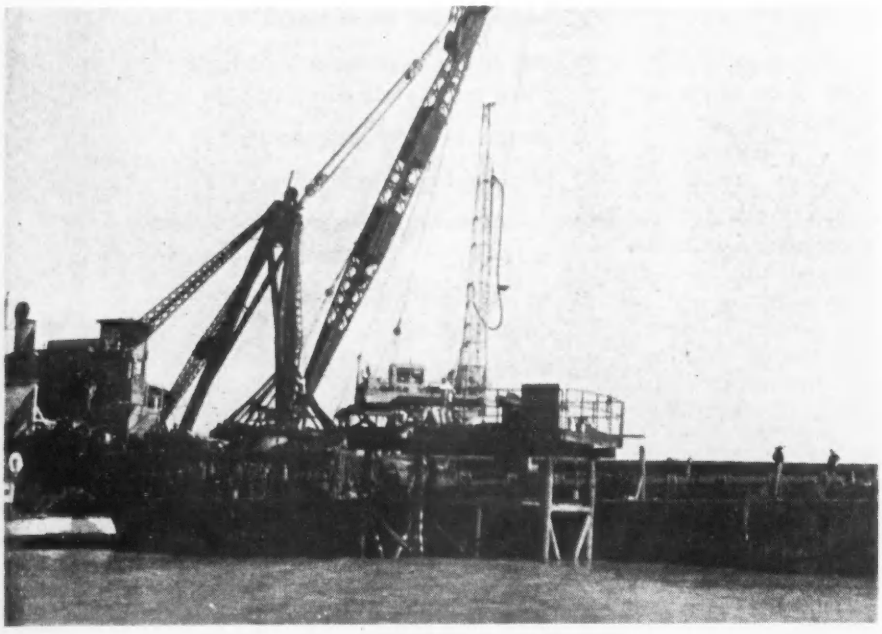
For one of the major producers operating off the Louisiana coast, this investigation is made concurrently with the erection of the drilling platform.

Building the Platform

After the location for a structure has been selected and its design completed, the material required for construction is assembled at a dock near New Orleans and loaded on barges for transportation to the site. Core drilling and testing equipment for the foundation investigation also are loaded, and materials are provided for the erection of a small platform for core drilling operations. Piles for the main structure are taken in sufficient quantity for the worst anticipated foundation conditions.

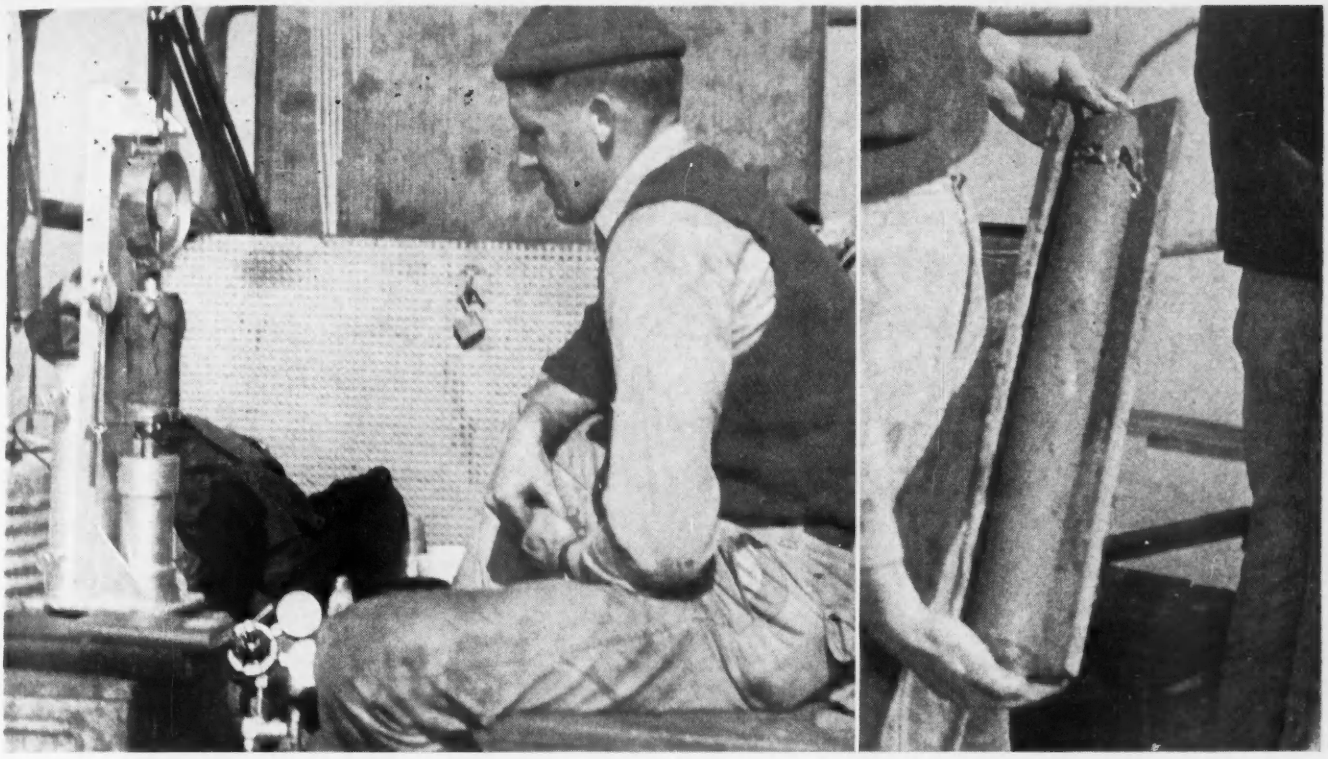
On arrival at the site, the first step in the operation is to set up the temporary core drilling platform. This pile-supported platform has a deck approximately 20 x 30 feet located about 15 feet above the water. The core drilling rig and testing equipment are set up on the platform and the boring is started immediately. While the investigation is in progress, construction is started on the main structure.

The core drilling rig employed is especially adapted for offshore investigation work. It is a rotary hydraulic rig, pow-



(Photo courtesy Geo. E. Failing Supply Company, Enid, Okla.)

The drilling platform was set in approximately 25 feet of water.



LEFT: Core testing apparatus carried on the drilling platform. Each core is tested immediately after being removed from the core barrel. The engineer reading the instruments is Roy Perkins, a member of the Greer and McClelland crew.
RIGHT: Core taken at a depth of 124 feet, two miles out in the Gulf of Mexico, at the mouth of the Mississippi River.

ered by a gasoline engine, skid-mounted and with a 38-foot mast.

Cores are taken for the investigation using a three inch diameter tube core barrel, two feet long. Formations are cored at intervals of about 10 feet, starting at the ocean floor and extending to a total penetration of from 200 to 300 feet.

Casing for the boring is first set to a penetration of only a few feet. After the first cores are taken, the casing is advanced to the bottom of the boring. After additional cores are taken, the casing is again advanced and this procedure is continued until a firm setting for the casing is secured, usually at a penetration of 80 to 100 feet.

When a final setting of the casing has been made, a four-inch manually operated blowout preventer is installed. This precaution, and weighted drilling mud, are used to help provide a measure of control in the event that formation gas is encountered before completing the boring.

Type of Soil

The predominant soil type encountered off the Louisiana coast is a dark gray organic clay, very soft near the surface and becoming slowly stiffer with depth. Most piles obtain the majority of their support from skin friction developed within this material. Tests of the organic clay are therefore of principal importance for the analysis.

From each core of the clay, two specimens six inches long are selected. One of these is coated with paraffin to preserve it in its natural condition for later laboratory tests. The other is immediately tested in unconfined compression. In this standard test for cohesive soils, an axial load is slowly applied to the three-inch diameter by six-inch high cylinder at a controlled rate of strain. Simultaneous observations of the applied load and the strain are made at regular intervals during the test until shearing failure occurs or until 20 percent strain is reached. The shearing strength or cohesion of the clay can then be computed from the results of that test.

The testing apparatus used for the unconfined compression test is a portable, hydraulic compression machine having a five-inch stroke and a load capacity of 2000 pounds. A small cylinder of nitrogen is used as a source of pressure to operate the hydraulic cylinder. A calibrated proving ring is used as a load indicator and a dial gauge is provided for strain observations.

Sand and cohesionless soil are usually encountered in only minor quantities in the Mississippi Delta area off the Louisiana coast. The effect of these soils on friction piles is estimated, using visual inspection of samples and considering the resistance offered by the material to penetration of the core barrel.

Test Data Analysis

As the core boring progresses, test data are analyzed and the safe capacity of the chosen pile section is determined at various depths of penetration. This is accomplished by integration of the unit friction at various depths, multiplied by the surface area of the pile. A curve of allowable pile capacity plotted against depth of penetration is then prepared, from which the required length of any particular pile in the structure can be selected, using the design load for that pile. This information is immediately passed on to the marine contractor, who can then begin driving piles to their final penetration.

The boring is advanced to at least 50 feet below the deepest penetration of any pile. Samples from lower depths are used for consolidation tests, performed later in the laboratory. These tests are required to estimate the amount of settlement that may be experienced by the structure under loads anticipated. Expected settlements are, in most cases, quite small.

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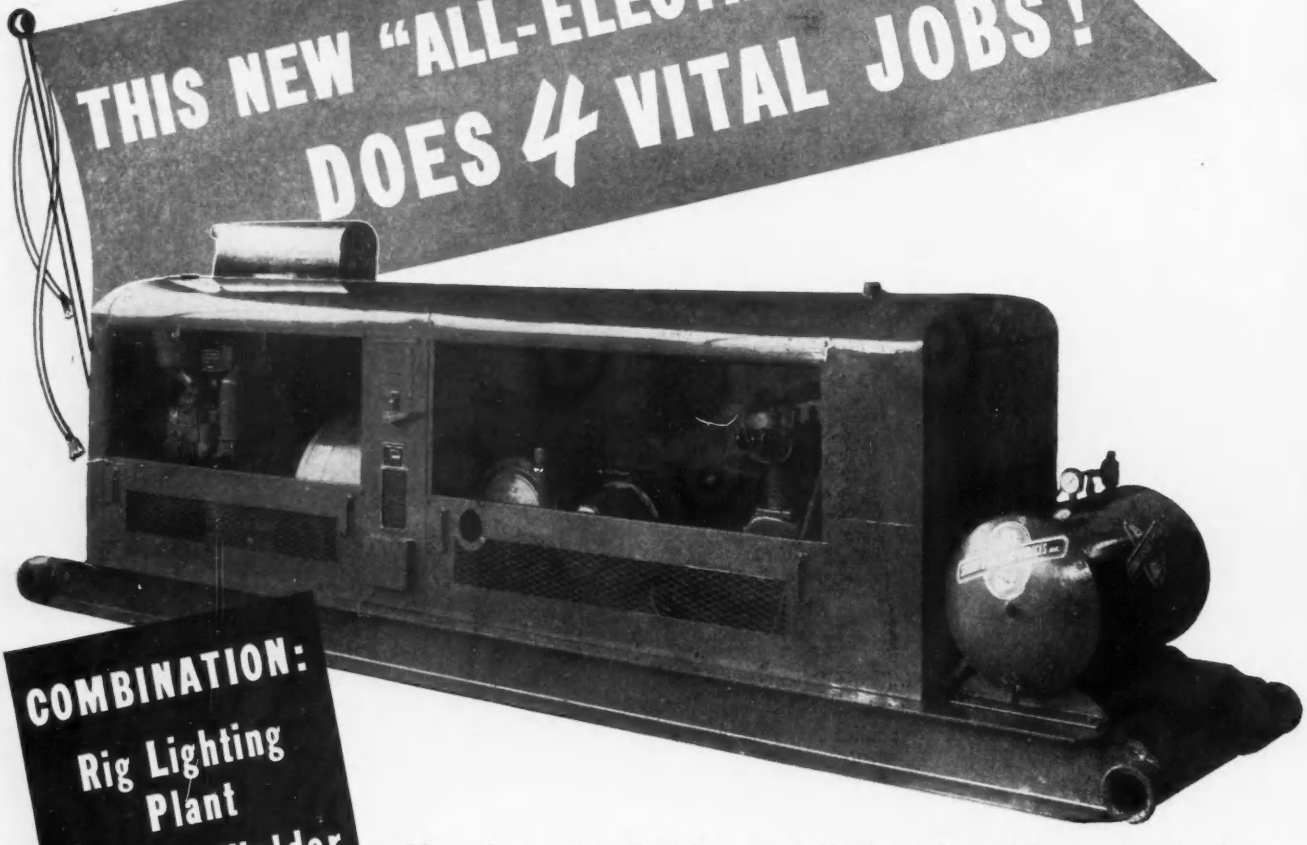

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The Fluoroscope as a Drilling Aid

By ARTHUR H. MESSERSMITH
President, Arvel Industries, Wichita Falls, Texas

Photos courtesy Arvel Industries, Wichita Falls, Texas

A battery type fluoroscope for field use, with separate switches for black (fluorescent) and white light to enable visual examination of fluoresced particles.

AN ACCURATE and exact analysis of well cuttings, necessary in all oil well drilling, becomes increasingly important in wildcat operations where all possible oil-bearing formations must be properly evaluated. Determination of drill cuttings by the naked eye can be very misleading and may be worthless in cases where flushing action of the drilling fluid has washed away surface traces of oil from the formation. This failure frequently occurs where the driller attempts to check a limestone or tight sandstone impregnated with light gravity oil.

Fortunately, the peculiar properties of hydrocarbons to fluoresce under ultraviolet light have provided the oil industry with a valuable tool. The fluorescence of petroleum has been known for many years and scientists have developed some very efficient and highly specialized equipment with which to study oil-saturated particles under the ultraviolet light. Unfortunately, most of this equipment is suitable for laboratory use only since it lacks portability and presents other objections which make it inadequate for actual field use. However, manufacturers of fluorescent equipment have cooperated with the oil industry in the development of highly refined, portable fluoroscopes which are now being used extensively in many oil fields. Such instruments, furthermore, are being used by superintendents, tool pushers and drillers, as well as geologists. Rig owners are making them a part of the regular drilling equipment and encourage field personnel to use them in analyzing well cuttings.

SIMPLER TYPES of instruments which may be carried to the rig and operated under current available there are described by the author, who points out operating procedure and limitations of various types of ultraviolet light sources. The article discusses basic principles, and is written for the man on the rig, to acquaint him with a possible aid in his work.

The portable field fluoroscope, in order to be practical, must be lightweight for easy handling, and simple enough for use under any and all conditions by men without any special training in its application.

When examining sample cuttings at night a hand lamp may be used effectively, but in daylight it still is necessary to examine the samples in darkness. To accomplish this, the ultraviolet lamp should be mounted in a light-tight compartment with an opening or door through which samples can be placed under the lamp and then closed in to keep out the daylight. An opening must be provided through which the samples can be examined. Such an opening may have the shape of the brow section of a stereoscope and in this way the fluoroscope becomes a very efficient, portable outdoor darkroom.

It is often desirable to pick out certain particles for further examination under the microscope or further testing with solvents. To facilitate this, it should be possible to switch from ultraviolet to white light while the eye is focused on the particle in question.

Since all portable ultraviolet lamps are electrically operated, it is necessary to have the proper source of energy. The ideal is a tube-type lamp operated from a six-volt battery. An instrument of this type may operate either from its own battery or from an automobile battery by means of a cord attachment that can be plugged into the cigar-lighter socket of the automobile. Another combination is the same battery type instrument with a cord to plug into any 110-115 volt A.C. outlet, making it suitable for either field or laboratory use.

The simplest type of all is an instrument using a 250-watt black-light bulb, commonly known as the "Purple X." This is a 110-125 volt lamp which may be used without special coils or transformers on either A.C. or D.C. current, which makes it possible to operate it from the light plant of the drilling rig. Many geologists have built their own fluoroscopes by using this type lamp. It has certain limitations. Its life is extremely short and it must be used intermittently because of the great amount of heat it

generates. It should not be allowed to burn more than three minutes at a time. Factory built instruments using this type bulb are ordinarily equipped with a momentary switch so that the light cannot be left on when not in use. Its chief advantage is its economy. The bulb and filter are one but the filter is not as effective as most separate filters. It passes some light from the violet bar of the visible spectrum and thus gives the entire sample a purplish cast, although it effectively brings out the fluorescent glow of the oil.

Wave Length

The wave length of ultraviolet generally conceded to be most effective for petroleum is 3650 angstroms. An instrument using this wave length would, of course, be useless to a mining geologist, who would find the wave length in the 2550 angstrom range more effective. The reason for this is that many minerals are negative under the longer wave length which is an advantage to the petroleum geologist as it eliminates many minerals that would serve only to confuse him.

As in most cases where equipment is involved, there is no substitute for experience in evaluating oil well samples. While the fluoroscope will bring out the fluorescent glow of even the faintest trace of crude oil and even the hydrocarbons of gas-saturated material, there is no definite rule as to the color or amount of fluorescence. The color may vary with the gravity of the oil and it may differ from one formation to another in the same well. Different locations or areas may show different characteristics. Ordinarily, when several wells are drilled on the same lease, the same characteristics should be looked for in corresponding formations. The usual fluorescent colors may range from yellow and green to blue with all the intervening shades encountered at times.

In the laboratory, solvents are an accepted means of analysis in connection with the fluoroscope, and no field man should overlook their usefulness at the well. Carbon tetrachloride is most commonly used and is very effective. A small bottle of it may be easily carried to the field. By selecting a few of the glowing particles and placing them in a tray, a few drops of the solvent will cause any oil therein to spread out from the cutting and form a cloudy substance in the clear solvent. Under the ultraviolet light this cloudy formation shows a fluorescent glow, and as the glow spreads it indicates the presence of oil in the formation being examined.

Some geologists like to use a long tray which has a number of depressions like an artist's water color tray. In this way a comparative analysis may be made if the samples are from different depths. Such a tray may be of plastic or glazed porcelain. Black vitreous ware and opaque black plastic are best for this purpose, as they are resistant to most solvents and the the depths may be marked on the black surface with a red or yellow grease pencil next to the depressions and as easily erased when samples from other depths are to be examined.

A fluorescence log may be prepared for each well for future reference. This should be based on the intensity of the fluorescence rather than on the color. This can be easily done by comparison with previously prepared samples and may be shown as an estimated percentage of fluorescence. In estimating the percentage, care should be used to allow for the masking effect of materials which fluoresce other than oil. Such a log can be a valuable record for future reference, especially in connection with other wells to be drilled in the same area.

While the portable fluoroscope is commonly considered a geologist's instrument, its usefulness in the operating departments should not be overlooked. Drilling superintendents should have one available and drillers should be taught how to use it. In this way, the driller may be able to report conditions encountered during the absence of the geologist and the superintendent.

About the Author

ARTHUR H. MESSERSMITH studied civil engineering at the Alabama Polytechnic Institute. After being associated with the accounting machine business and also practicing accounting for 15 years he was attracted to the oil industry and moved to Texas. His hobby is geology and through the medium of literature and actual practical experience in the field he acquired the extensive working knowledge which eventually led him into the specialized field of sample analysis. He became interested in ultraviolet light and its application in oilfield and laboratory work, and founded Arvel Industries shortly after World War II. When he is not in the oil fields checking formation samples he designs and supervises the manufacture of specialized light machinery.

Member of drilling crew examines drill cuttings in a fluoroscope. Cord connects the instrument to the car battery. Connection is made by plugging into cigar-lighter socket of the car.

Drilling Rig Belt Drives

By TYLER G. HICKS
Hicks Associates

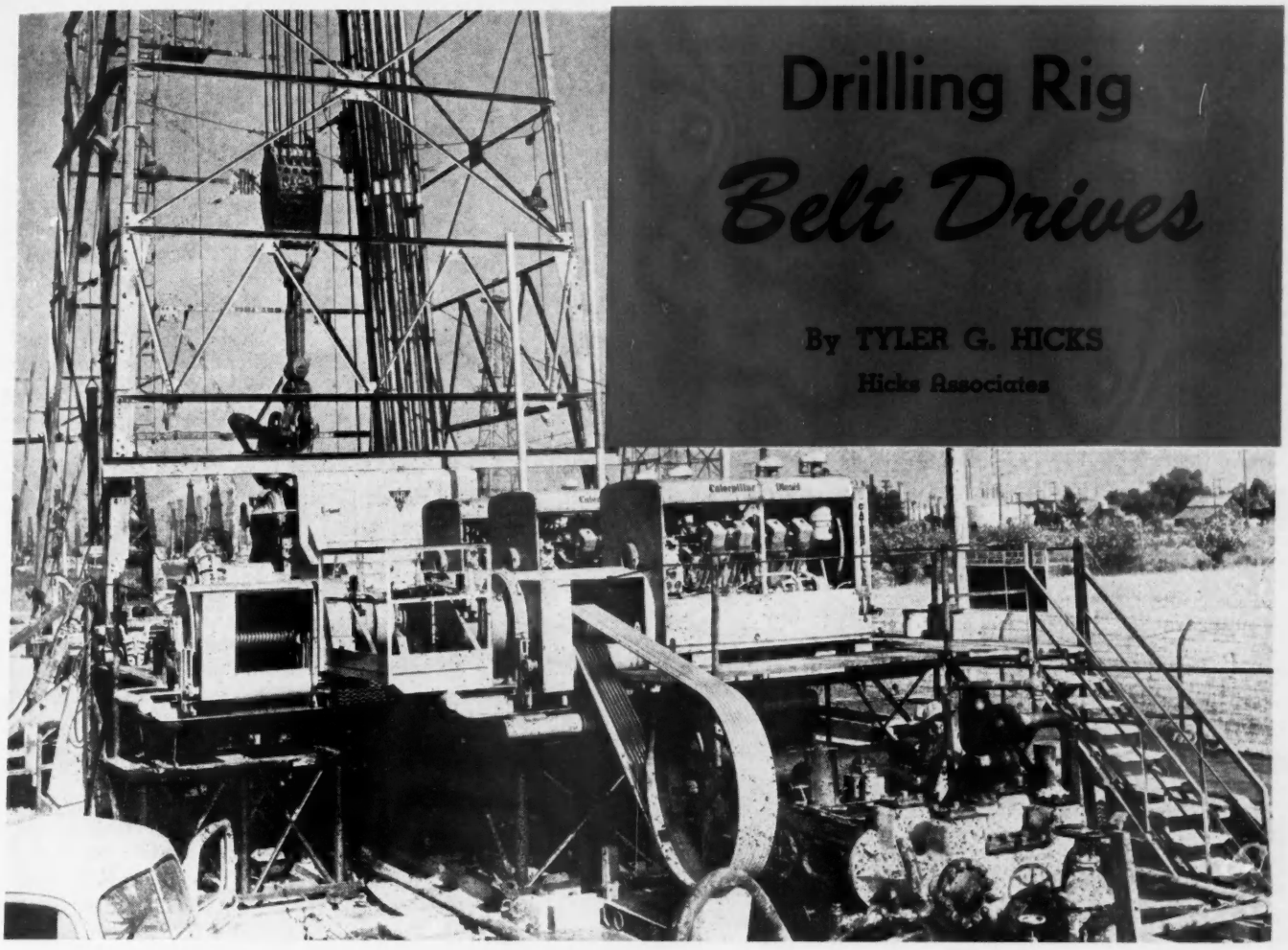

FIGURE 1. This type of V-belt drive, powering a mud pump from an elevated jack shaft, imposes most severe service on the belts, which must continue to operate through sun, rain, mud spray, dust and wide temperature variations.

THE AUTHOR discusses elemental factors in V-belt drive selection and operation, illustrating the subject of proper belt selection with typical examples of different types of drives. Reference tables given by author simplify belt choice and insure against overloading.

BELTS used in modern rig pump and generator drives are usually of the V type. These have supplanted the flat leather belt because they require less space, maintain more exact speed ratios, are smooth starting, require less maintenance, and are easy on bearings. Since reliability and continuity of operation are of prime importance in drilling operations, proper application of V-belts is necessary; otherwise, important power and pumping services might be interrupted. A good working knowledge of proper application procedures for belts used in drilling auxiliaries can be obtained by a study of typical belt types, construction, and operating characteristics.

Belt Types

Standard industrial V-belts are made in five cross-sections each in a variety of lengths to suit particular applications. Typical dimensions and other physical characteristics of standard belts are summarized in Table 1. Sizes and weights are somewhat approximate because they vary slightly from one manufacturer to another. Materials of construction also vary, but most modern V-belts will be found to consist of fabric and cords molded in rubber and covered with fabric.

Recommended cross-section for various motor horsepowers and speeds are listed in Table 2. Since there is a most economical cross-section for every drilling rig application, Table 2 is handy when selecting belts. Cross-sections in parentheses are not usually the most economical but they are used where pulley dimensions make them desirable.

TABLE 1

Properties of V-Belts

Cross-Section	Size, Outside Width x Depth, Inches	Wt., Lb. per Ft.	Min. Grooved Pulley Pitch Diam., Inches	Min. Flat Pulley Diam., Inches
A	$\frac{13}{32}$ x $\frac{1}{4}$	0.06	3	17
B	$\frac{17}{32}$ x $\frac{21}{32}$	0.106	5.5	24
C	$\frac{11}{16}$ x $\frac{7}{8}$	0.20	9	42
D	$1\frac{1}{4}$ x $1\frac{1}{4}$	0.40	13	52
E	$1\frac{15}{32}$ x $1\frac{13}{16}$	0.60	21.5	62

The term "standard V-belt drive" presumes use of grooved pulleys on both the driving and driven unit. When the large pulley diameter is several times that of the smaller, a grooved large pulley may not be necessary. The drive then consists of a grooved small pulley, a set of standard V-belts, and a flat large pulley, and is known as a "V-flat drive." These drives are almost as common as the standard V-belt drive. Mud pumps, air compressors, and generator drives are the most common applications in drilling operations.

Belt Selection

There are many instances where belts must be selected for new or existing equipment used in drilling. During plan-

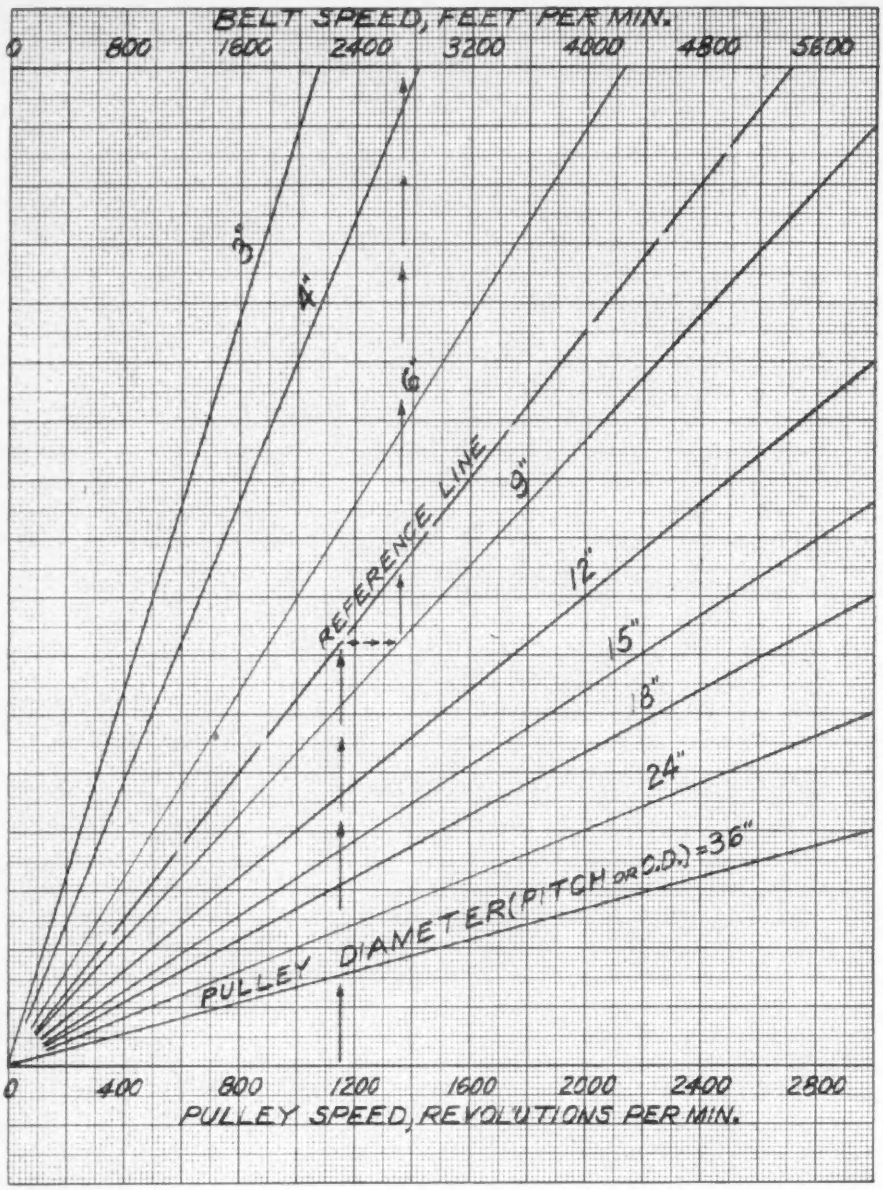

FIGURE 2. Chart for quick determination of belt speed when the pulley speed and diameter are known. Enter at the pulley speed in revolutions per minute and project vertically to the reference line. From the intersection run across horizontally to the pulley diameter curve and then up vertically to read the belt speed. Results obtained from the chart are sufficiently accurate for all ordinary belting problems.

TABLE 2

Recommended V-Belt Cross-Sections for Various Horsepowers and Speeds

Horsepower Transmitted	MOTOR SPEEDS, REVOLUTIONS PER MINUTE						
	1750	1160	870	690	575	490	435
½	A	A	A	....	....	....	....
¾	A	A	A	....	....	....	....
1	A	A	A (B)	....	....	....	....
1½	A	A (B)	B (A)	....	....	....	....
2	A	A (B)	B	....	....	....	....
3	B (A)	B	B	....	....	....	....
5	B	B	B	....	....	....	....
7½	B	B	B	....	....	....	....
10	B	B	B (C)	....	....	....	....
15	B (C)	B (C)	C (B)	....	....	....	....
20	C (B)	C	C	C	....	....	....
25	C	C	C	C	D	....	....
30	C	C	C	D	D	....	....
40	C	C (D)	C (D)	D	D	....	....
50	C	C (D)	D (C)	D	D	E	E
60	C	D (C)	D (C)	D	D	E	E
75	C	D	D	D	D (E)	E	E
100	C	D	D	D (E)	E (D)	E	E
125	C	D	D	D (E)	E (D)	E	E
150	C	D	D	E (D)	E	E	E
200	C	D	D	E	E	E	E

ning of composite rigs, maintenance of worn equipment, and changes in power transmission belt type, it is usually necessary to choose a set of belts for given operating conditions. Belt calculations involve only simple arithmetic, but the severe operating and atmospheric conditions ordinarily encountered in drilling require that the service conditions be most carefully considered. A typical selection problem will illustrate the methods generally used.

Example

PROBLEM: It is proposed to drive a 450 revolutions per minute pump through V-belts from a 25 horsepower, 1150 rpm motor. Center distance between pump and motor shafts is approximately 27 inches. Determine belt cross-section, length, and number of belts necessary for the drive.

SOLUTION: Before the section can be chosen, the actual horsepower of the drive must be determined. Table 3 lists service factors based on average conditions. Inspecting these, it is seen that factors **c, e, f, g** and **i** will probably apply. This means that continuous service, excess oil, dust, heat, and water might be encountered at the drilling site during belt operation. Hence, summing the service factors and taking 50 percent of the result, as noted in Table 3, $0.3 + 0.2 + 0.25 + 0.2 + 0.2 = 1.15/2 = 0.575$, say 0.60. Therefore, service factor $= 1.00 + 0.60 = 1.60$.

Then, actual horsepower of drive $= (1.6)(25) = 40$. From Table 2, a C or D section is suitable for a 40 horsepower drive. The ratio of driver to driven speed is, $1150/450 = 2.56$. From Table 1, the minimum pitch diameter for a C section is 9". Hence, the pitch diameter

TABLE 3

Service Factors for V-Belt Drives

Operating Conditions	Service Factors
a. Starting peaks in excess of motor rating and/or momentary running peaks in excess of motor rating:	
(1) 150 percent of motor rating maximum.	0.20
(2) 200 percent of motor rating maximum.	0.50
(3) 250 percent of motor rating maximum.	0.80
b. Frequent starting and stopping	0.20
c. Continuous service (16 to 24 hrs./day)	0.30
d. Pulsating driver (gas or Diesel engine)	0.20
e. Excess oil	0.20
f. Excess dirt, sand, or dust	0.25
g. Excess heat to 140° F., maximum	0.20
h. Excess heat to 200° F., maximum	0.40
i. Excess water or other liquids which do not attack rubber or fabric	0.20

Where two or more conditions exist sum the individual service factors and correct as given below.

Two Conditions—Use 85% of the sum of the two factors.
Three Conditions—Use 70% of the sum of the three factors.
Four Conditions—Use 60% of the sum of the four factors.
Five Conditions—Use 50% of the sum of the five factors.

of the driven pulley when the driver pulley has a 9″ pitch diameter is, 9(2.56) = 23″. Checking with manufacturer's tables of standard pulley sizes, it is seen that both the required diameters are available. The D section was not considered because Table 2 shows that it is not the most economical type.

The length of each belt is found from:

$$L = 2K + 1.57(D + d) + \frac{(D - d)^2}{4K} \quad (1)$$

where

L = belt pitch length, inches
D = pitch diameter of large pulley, inches
d = pitch diameter of small pulley, inches
K = center distance between shafts, inches

For this problem,

$$L = 2(27) + 1.57(23 + 9) + \frac{(23 - 9)^2}{4(27)}$$

L = 106.02 inches, closely

The nearest stock size of V-belt, from manufacturer's tables, is 106.9 inches.

The center distance necessary with a 106.9-inch long belt and the pulley dimensions given above is,

$$K = \frac{L - 1.57(D + d) - \frac{D^2 - d^2}{1.57(L - R)}}{2} \quad (2)$$

where the symbols are as before and $R = \frac{\text{driver rpm}}{\text{driven rpm}}$

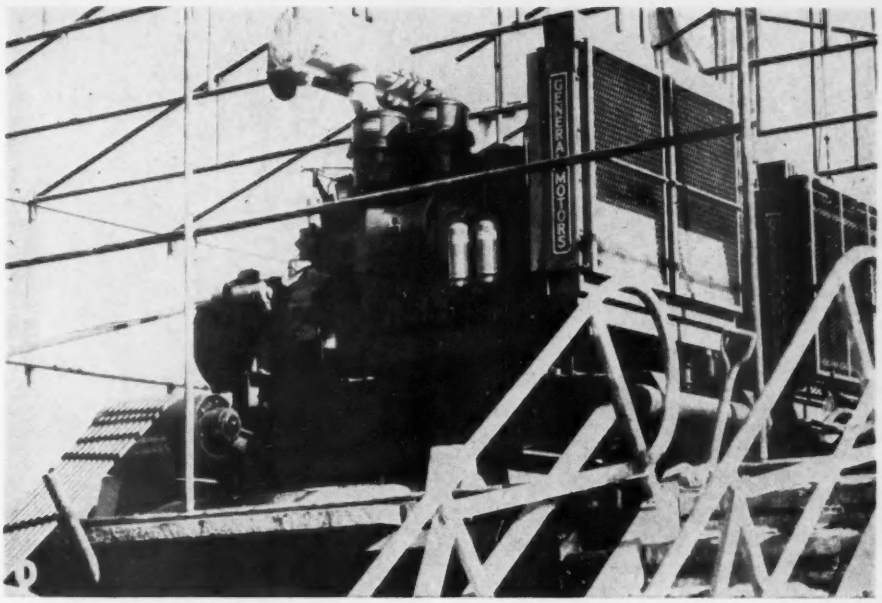

FIGURE 3. Exposed to weather and possibility of accidental damage, the V-belts driving the mud pump at extreme left, as well as the compounding belts on the engine shaft extension, are being used under most severe conditions.

Hence,

$$K = \frac{106.9 - 1.57(32) - \frac{(23)^2 - (9)^2}{1.57(106.9 - 2.56)}}{2}$$

K = 27.0 inches, closely

The arc of contact of the belts is given by:

$$AC = 180° - \frac{60(D - d)}{K} \quad (3)$$

or

$$AC = 180° - \frac{60(23 - 9)}{27}$$

$$AC = 148.9°$$

TABLE 4
Horsepower of A, B, C, D, and E Belts

	Motor Sheave Pitch Diam., Inches	BELT VELOCITY, FEET PER MINUTE							
		1000	1500	2000	2500	3000	3500	4000	4500
	3.0	0.7	1.0	1.3	1.5	....	....	....	....
	3.4	.8	1.1	1.5	1.7	2.0	....	....	....
A	3.8	.9	1.3	1.6	2.0	2.2	2.5	....	....
	4.2	.9	1.4	1.8	2.1	2.4	2.7	2.8	....
	4.6	1.0	1.4	1.9	2.3	2.6	2.8	3.0	3.2
	5.0 and up	1.0	1.5	2.0	2.4	2.7	3.0	3.3	3.4
	5.4	1.4	2.0	2.6	3.1	3.5	3.8	4.0	4.0
	5.8	1.5	2.1	2.8	3.3	3.8	4.1	4.4	4.4
B	6.2	1.6	2.3	2.9	3.5	4.0	4.4	4.7	4.8
	6.6	1.7	2.4	3.1	3.7	4.3	4.7	5.0	5.1
	7.0 and up	1.8	2.5	3.2	3.9	4.5	4.9	5.3	5.4
	9.0	2.8	4.2	5.5	6.6	7.6	8.4	9.1	....
C	10.0	3.1	4.6	6.1	7.3	8.5	9.4	10.3	10.7
	11.0	3.4	5.0	6.5	8.0	9.2	10.3	11.3	11.8
	12.0 and up	3.6	5.3	7.0	8.5	9.8	11.0	12.2	12.7
	13.0	5.1	7.5	9.7	11.6	13.3	14.6	15.6	....
	14.0	5.6	8.2	10.7	12.9	14.4	16.5	17.8	....
D	15.0	6.1	9.0	11.7	14.1	16.3	18.1	19.6	20.3
	16.0	6.5	9.6	12.5	15.1	17.5	19.5	21.3	22.1
	17.0 and up	6.8	10.1	13.2	16.0	18.6	20.7	22.8	23.5
	21.0	8.5	12.5	16.2	19.6	22.7	24.9	26.6	....
	22.0	9.0	13.2	17.2	20.8	24.0	26.6	28.5	....
E	24.0	9.8	14.5	18.9	23.0	26.5	29.5	31.9	33.5
	26.0	10.5	15.6	20.3	24.7	28.6	32.0	34.7	36.7
	28.0 and up	11.1	16.5	21.6	26.3	30.5	34.2	37.2	39.5

TABLE 5
Arc of Contact Correction Factor

Arc	180°	170°	160°	150°	140°	130°	120°	110°
Factor	1.00	0.98	0.95	0.92	0.89	0.86	0.83	0.79

Belts for Auxiliaries

V-belts used in pumping and power rigs are most frequently installed in multiple because a single belt cannot transmit the required power. Table 4 summarizes power ratings for belts used on drilling auxiliaries. Entering Figure 2 as a driving pulley speed of 1150 rpm and projecting as shown, belt speed is found to be 2720 feet per minute. From Table 4, for a C section, a nine-inch motor sheave pitch diameter, and a 2720 feet per minute belt speed, each belt can transmit seven horsepower. Correcting for arc of contact, using the factor 0.91 from Table 5, horsepower per belt = 7(0.91) = 6.3. Hence, 40/6.3 = 6.35, or seven belts are required.

This problem indicates the principal methods in use for pump and generating drive belt selection. Some belt manufacturers use slightly different tables from those presented here but the basic data included are essentially the same. Selection procedure for V-flat belt drives is similar to that shown above for standard V-belts. As can be seen by a study of this example, the service factors used are most important in final belt selection. For best economy, the service factor selected should be exact but determination of the correct value is often difficult. In general, a value somewhere in the range of 1.2 to 1.6 should be

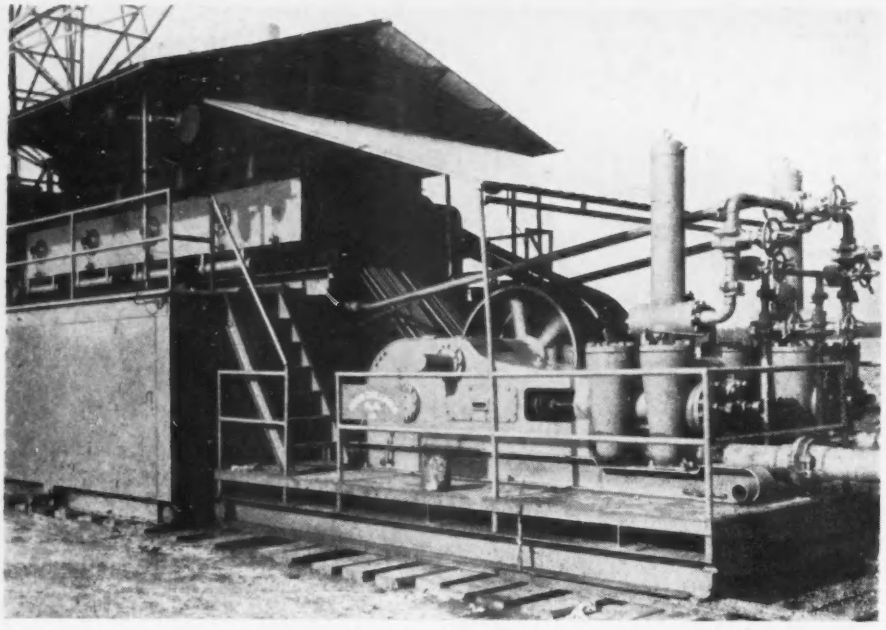

FIGURE 4. Extending between the elevated power shaft of the compounding hookup to the pump sheave below, these belts are subject to overload through mis-alignmnt if pump or derrick foundation shifts, but are afforded protection against weather by penthouse roof.

selected, according to whether moderate or severe service conditions are anticipated.

V-Flat Drives

The advantages of flat drives result from the lower cost of ungrooved pulleys and the ease with which an existing flat belt drive can be transformed to a V-belt drive. V-flat drives are most practical when the speed ratio is at least 3 to 1, or more, and the center distance is about equal to the diameter of the large flat pulley. When these conditions obtain in pump or generating drives, about the same number of V-belts are required as for two grooved pulleys. Although longer center distances may be used, the arc of contact on the larger pulley is decreased and the number of V-belts needed is increased.

For equal pulling power of flat and grooved pulleys, the belt arc of contact on the flat pulley should be about twice that on the grooved pulley. In general, maximum pulling of the belts will be obtained when flat pulley arc of contact is 240 to 250 degrees and the grooved pulley arc 120 degrees or less. In any case, the sum of the respective arcs of contact will always equal 360 degrees, or a full circle. The least number of belts is required when the pulling powers of both pulleys are equal. Experience shows that V-belt drives are most economical and practical for oilfield equipment when the belt arc of contact on the flat pulley is between about 240 and 265 degrees.

Installation and Maintenance

Selection of the proper belts for pump and generator drives is only the first step toward reliable operation. Correct installation and maintenance procedures are equally important. Many good belts have been ruined by crude installation methods and inefficient maintenance.

A minus allowance on shaft center distances is necessary to permit belt installation without strain. Where a take-up (idler pulley) is used, a plus allowance for take-up must be provided. Table 6 lists the minimum allowances for installation and take-up. These values should never be decreased, otherwise belt life may be considerably shortened. Pulleys should always be exactly in line and the shafts of driving and driven units parallel.

Common practice in oil fields, where belt renewals must often be made quickly, has been to pry the belts onto the pulley with a handy bar. Such prying almost always damages the inner surface of the belt and strains the fibers. As a result, the belt is made oversize, does not deliver its rated power, and rapidly wears out. To prevent undue strain and wear on the belt during installation, the driver should be moved closer to the driven unit and the belts slipped over the pulleys. The short time and small amount of labor required to move the driver in usual oil field installations is well repaid by increased belt life. A whole set of belts must be installed whenever one or more belts wear out. Use of new and old belts on the same drive is seldom satisfactory because the load is not equally divided among all belts. Rapid wear of the new belts usually results.

When first installed, new belts stretch somewhat and the slack must be taken up by moving the driver further from the driven unit. Once the slack has been taken up sufficiently, readjustment is seldom necessary because most modern belts are pre-stretched at the factory. Proper belt tension is ascertained by striking the section between the pulleys with the hand. A uniform, springy vibration indicates that the proper tension has been secured. A weak vibration indicates that the belts do not have enough tension.

The only maintenance which modern V-belts require is of a preventive nature. Belt dressings should never be used. If the belts slip during heavy loads, tension may be insufficient, pulley grooves worn, or the belts need replacement. Water, oil, sand, and dust should be kept off belts by proper shields, but sufficient room for rapid, continuous circulation of air through the shields is necessary. High temperatures in the vicinity of belts must be avoided if long, reliable service is expected.

V-belts have proven well adapted to oil field service when properly selected, installed, and maintained. Petroleum engineers can improve rig reliability and economy by using the selection and operating methods outlined in this article. Since any savings which result usually appear in many pieces of equipment, the time and effort spent in proper care is well worthwhile.

TABLE 6

Installation and Take-Up Adjustments

Nominal Length of V-Belt, Inches	Minimum Allowance Below Standard Center Distance for Installation, Inches					Minimum Allowance Above Standard Center Distance for Take-up, Inches All Cross-Sections
	A	B	C	D	E	
26 to 37 inclusive	¾	1	....	....	....	1
37 to 59 inclusive	¾	1	1½	....	....	1½
60 to 89 inclusive	¾	1¼	1½	....	....	2
90 to 119 inclusive	1	1¼	1½	....	....	2½
120 to 157 inclusive	1	1¼	1½	2	....	3
158 to 194 inclusive	....	1¼	2	2	2½	3½
195 to 239 inclusive	....	1½	2	2	2½	4
240 to 269 inclusive	....	....	2	2½	2½	4½
270 to 329 inclusive	....	....	2	2½	3	5
330 to 419 inclusive	....	....	2	2½	3	6
420 and above	....	....	....	3	3½	1.5% of length in feet

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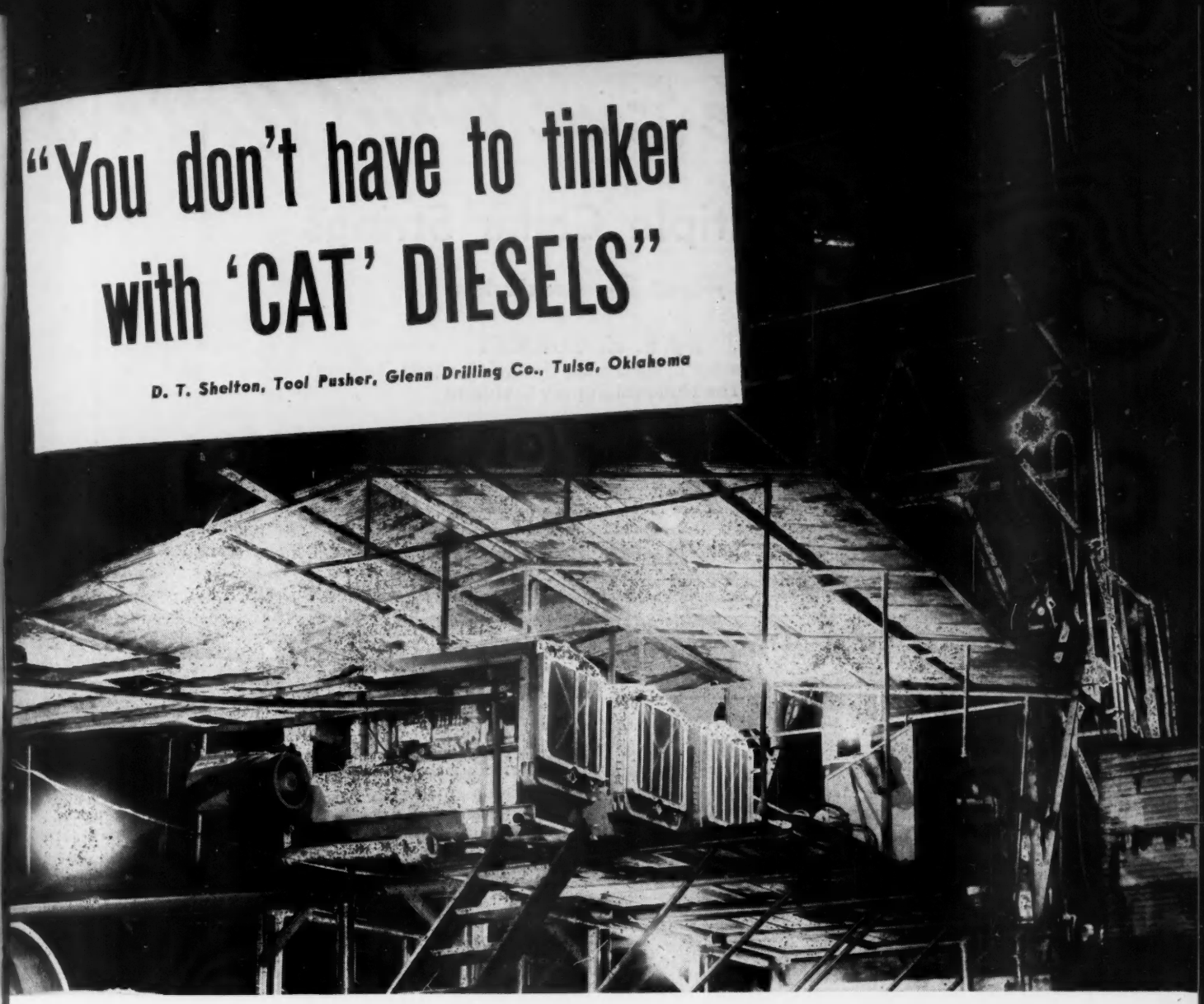

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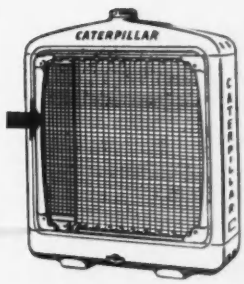

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Replaceable End Drill Collars

in Multiple Collar Strings

Part 2—Conclusion

By B. E. CURRAN
Assistant Director of Research, Spang-Chalfant Division
The National Supply Company

A NEW MEANS of combating the problem of joint failures of drill collars by means of a new design of drill collar with replaceable ends was described in Part 1. Part 2 tells how to select replaceable end drill collars in accordance with principles outlined in Part 1 and how to use them.

SEMI-PERMANENT connections for replaceable end drill collars may be selected by means of the chart in Figure 7, applying the principles discussed in Part 1 last month, based on bore and outside diameter of the drill collar. It should be observed in using this chart that whenever the chamber at the semi-permanent connection is more than 1/16 inch, the small diameter at the bottom of the chamber should be used instead of the actual O.D. in order to get a well-balanced joint.

The selection chart shown in Figure 7 was designed for the purpose of selecting a semi-permanent connection in accordance with the foregoing principles depending on the bore and the O.D. of the drill collar. It should be pointed out, however, that in the use of this chart, whenever the chamfer at the semi-permanent connection is more than 1/16-inch, the small diameter at the bottom of the chamfer should be used instead of the actual O.D. in order to get a well-balanced joint.

The taper joint design used on replaceable end collars allows a wide latitude of choice on the part of the purchaser but in general it will correspond closely to the standard API tool joint connection used on drill collars of the bore and O.D. specified. In general, the connection which will give the most symmetrical distribution of wall thickness for a given combination of bore and O.D. can be readily determined from an examination of the taper joint selection chart shown in Figure 8. Unless otherwise specified the chamfer used for the taper joint of replaceable end collars is the standard tool joint chamfer.

All replaceable end subs intended for original assembly are carefully lubricated and made up on the drill collar bodies with an accurately determined amount of torque at the mill. This insures proper make-up in the first instance and sets a predetermined standard for the crews to work to when removal and replacement becomes necessary on the rig. Complete with ends, the over-all assembly can be used in exactly the same manner as the corresponding conventional box-and-pin or double box type of collar, respectively.

The difference between using a string of replaceable end collars and a string of double box collars with double pin subs between them is quite pronounced, however. In the case of the double box collars, the collars are rotated so as to occupy different positions in the string and are even inverted from time to time, while the double pin sub is not considered a fixture on any particular collar but merely a connecting member between them. Successive breakouts are deliberately staggered so as to distribute the wear and tear more evenly over all the connections. In the case of the replaceable end collars, the connection between the replaceable end subs and the drill collar body is never used as a make and break connection.

This same distinction also serves to differentiate between the service imposed on the taper joint and the semi-permanent connection of the replaceable end collars; the taper joint is subjected to shoulder wear, but the semi-permanent connection is not.

Shoulder Wear

By shoulder wear is meant the removal or deformation of metal from the face of either or both of the shoulder faces of the connection, i.e., the face of the shoulder on the pin member or the face of the box end itself. This can come about by mashing down the metal with excessive contact pressure where the shoulder area is insufficient to begin with, by ordinary wear between matching faces after a considerable number of successive make-ups, by abrasion where sand or grit is trapped between the faces on make-up, by galling or smearing the metal where improper or inadequate lubrication is provided, by excessive friction between the mating members because of improper make-up or damaged threads, or by any number of related causes. And shoulder wear is principal cause of joint failures.

For instance, after a drill collar connection has been shouldered up, any further advance is resisted by the shoulder. As a consequence when additional torque, or twisting force, is applied to the joint to make it up power-tight, both the box end and the shoulder are compressed while the pin member itself is stretched. As a result of this compression a substantial amount of contact pressure is built up between the face of the shoulder and the face of the box end. And if these faces are smoothly finished and the mating members of the joint properly aligned, this contact pressure will be more or less evenly distributed over the entire contact area.

The amount of contact pressure required is determined by the amount of deflection or bending which the drill collar string will have to withstand in the hole. For instance, if the drill collar string is flexed to one side of the hole, the joint will tend to be opened up on the outside of the deflection curve and the mating faces will tend to be pulled apart from each other. If, however, they were sufficiently compressed when the joint was made up, they will tend to recover their original length elastically as the joint opens. And if their combined elastic recovery is greater than the tendency of the joint to open up, they will never quite lose contact with each other, and the original contact pressure will never be altogether lost.

On the inside of the deflection curve the contacting faces of the shoulder and the box end will be subjected to additional compressive stress over and above that which was built up between them when they were originally made up. The contact area, therefore, must always be

sufficient to accommodate this additional stress without yielding.

When these two conditions are satisfied, that is, some contact pressure is maintained on the outside of the deflection curve and enough contact area is provided to take care of the extra load on the inside of the curve, two things are achieved. The stresses superimposed on the shoulder faces by rotating the collars in a deflected condition will always be compressive, and the stresses imposed on the pin will always be in tension. This is significant because alternating stresses which are either completely on the compressive side or completely on the tensile side are not nearly as severe from the standpoint of fatigue as equivalent stresses which go through a complete reversal for each revolution.

This is the reason for the so-called pre-stressing of bearing races, crankshafts, and other working parts in a multitude of applications where cyclic stresses are developed. It is also true in the case of drill collar joints. For this reason it can be seen that an adequate contact area between the face of the shoulder and the face of the box end must be provided initially and maintained in good condition throughout the service life of the joint.

If such an area is not provided or if it becomes impaired in any fashion by galling, wear, abrasion, or otherwise, the contact pressure between the shoulder faces will become unevenly distributed over the contact area. Abnormally high pressures will be developed at the high spots, while in the low spots the contact pressure may be dangerously reduced or lost altogether. Then when the string is rotated, especially in a deflected condition, the shoulder faces rock over the high spots and open up over the low spots. This is known as wobbling, and when it occurs it throws the entire stress due to bending on the metal at the root of the last engaged pin thread.

Because the pin is no longer prestressed, the metal at the root of the thread is stretched when it is on the outside of the deflection curve and compressed when it is on the inside. And if the pipe continues to rotate in this condition, each revolution produces a complete reversal of the stresses which keep stretching and relieving the metal at the bottom of the notch formed by the thread root.

These alternating stresses are known as fatigue stresses; and, if they exceed the so-called endurance limit of the metal at that point, they will eventually open up sub-microscopic cracks known as fatigue cracks. These cracks then continue to get deeper and deeper with each further revolution, reducing the cross-sectional area until it can no longer support the load being applied. When this point is reached sudden failure occurs.

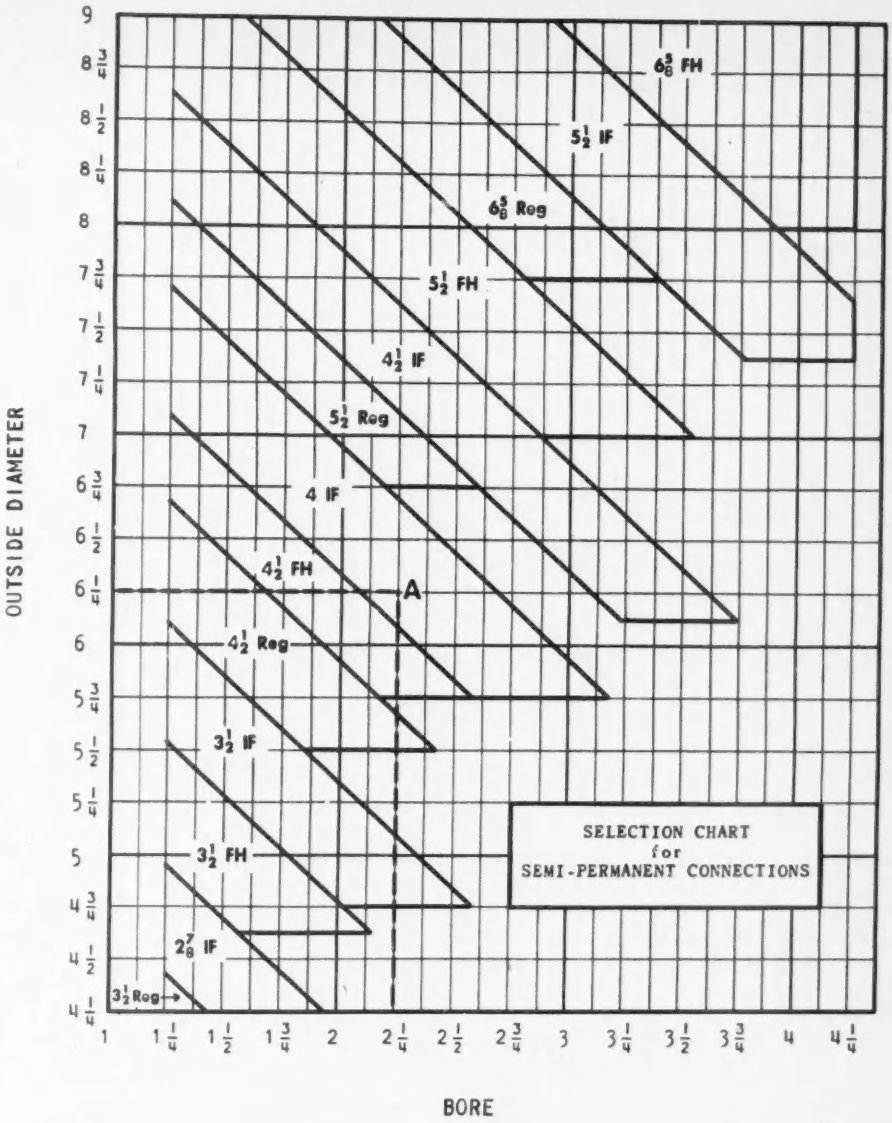


FIGURE 7. Example: Given a drill collar 6¼ inches outside diameter by 2¼-inch bore, what is the most symmetrical semi-permanent connection? Enter left side of chart at 6¼ inches and go horizontally to intersection of vertical erected at 2¼-inch bore. This intersection "A" occurs in the area marked "4 inches Internal Flush"; therefore, this particular connection would be the most symmetrical for the given case.

The theory behind the use of replaceable end subs on drill collars intended for multiple collar strings is really very simple. Since some shoulder wear, as a result of repeatedly making up and breaking out the taper joint, is almost inevitable; and, since this is probably the principal cause of taper joint failures, it seems unlikely that taper joint failures can ever be eliminated entirely. On the other hand, however, it seems just as reasonable to suppose that, if a connection could be made up, once and for all, and then left undisturbed instead of being broken out every trip or so, like an ordinary taper joint, such a connection ought to stand up indefinitely because, for all practical purposes, it would be entirely relieved of wear and tear on the shoulder faces.

Used as the semi-permanent connection between the drill collar body and demountable taper joint subs at either end of a drill collar, such a connection would make it convenient and easy to replace defective taper joint members at any time without making the overall assembly any more vulnerable than a conventional collar.

This rig replaceability feature, then, is the principal advantage of using replaceable end collars. Whenever a taper joint becomes worn or galled, or unserviceable for any reason, or if the O.D. has been reduced enough to warrant its removal, any replaceable end can be removed and replaced with a spare end on the rig and without any special equipment or supervision whatsoever. This is accomplished by simply breaking out the particular semi-permanent connection in the same fashion as

the taper joint connections are broken out in coming out of the hole to make a trip. The only difference is that a slightly greater amount of torque, or unscrewing force, than is necessary for the taper joints may be required for the semi-permanent connection. This, however, can easily be developed by using snatch blocks and taking an extra wrap or two on the cathead. In bucking up the replacement end the proper make-up torque is insured by using the same combination of blocks and wraps as was used to break out the one removed.

Another advantage of replaceable end collars is that the relative size of the replaceable ends makes it possible to improve their quality above the general drill collar level by performing operations on them that could not be conveniently performed on a full length collar.

For instance, heat treatment approaching that of tool joints for uniformity and hardness can be secured by quenching the stock for replaceable ends after boring instead of as a solid round. And finally, the size of the pieces also opens up the possibility of resorting to a wide variety of finishing techniques such as vapor-blasting, lubriting, thread rolling, etc., for improving the resistance to galling and the endurance limit in fatigue.

In February, 1948, a trial string consisting of six 5¾-inch O.D. x 2¼-inch I.D. replaceable end drill collars of the type just described was placed in service as the bottom section of a 17-collar string being used to drill below the salt section in West Texas.

On the first two wells the remainder of the string consisted of a middle section of six collars equipped with shrink-type tool joints of another make as replaceable ends and a top section of five conventional box and pin collars. The conventional collars, for which a joint expectance had already been established by the previous experience of the operator conducting the test, were not intended as a part of the test program, but were simply used to fill out the string pending the arrival of six other collars equipped with still another make of shrink-type tool joints as replaceable ends. These latter collars were received in time to be picked up as the middle sections on the third well, at which time the conventional collars were laid down and the first six tool joint equipped collars, which had formed the middle section on the first two wells, were moved up to form the top section of what had now become an 18-collar string.

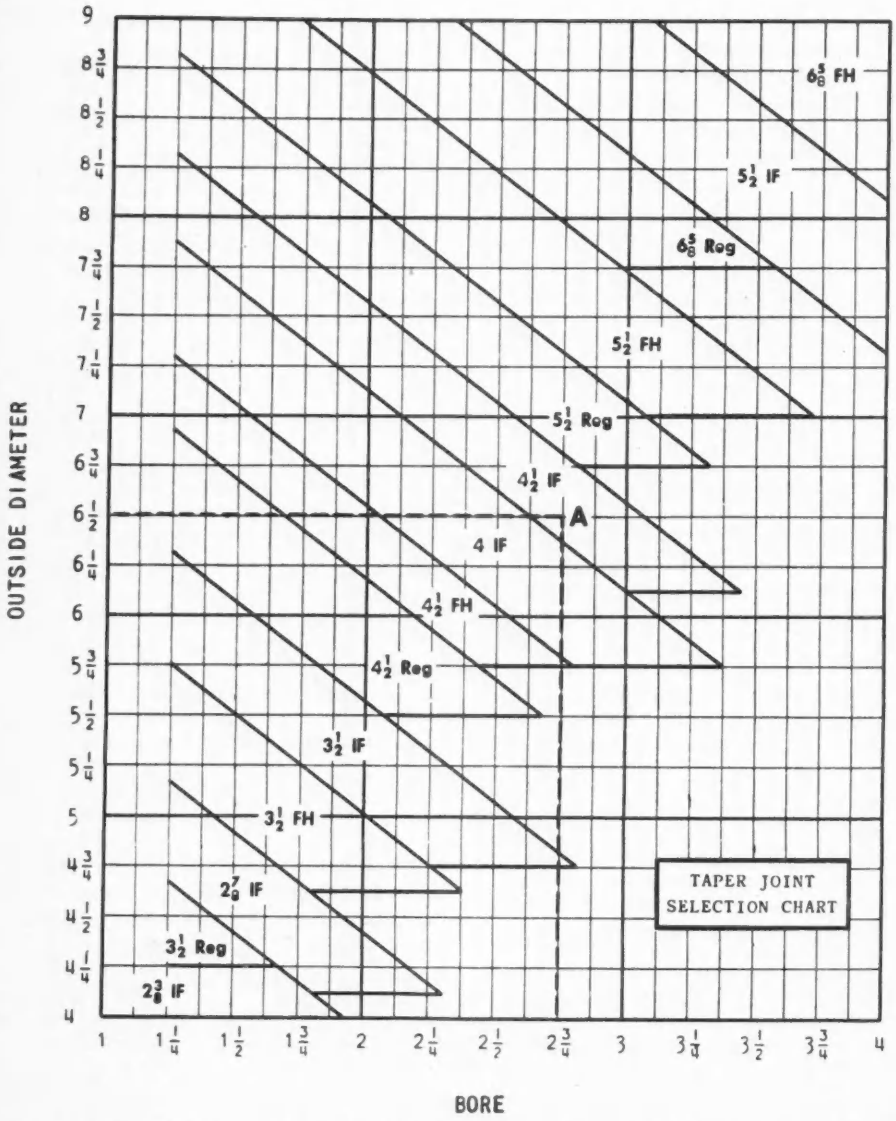


FIGURE 8. Example: Given a drill collar 6½ inches outside diameter by 2¾-inch bore, what is the best connection to use? Enter left side of chart at 6½ inches and go horizontally to intersection of vertical erected at 2¾-inch bore. This intersection "A" occurs in the area marked "4½ inches Internal Flush"; therefore, this particular connection would be the most symmetrical for the given case.

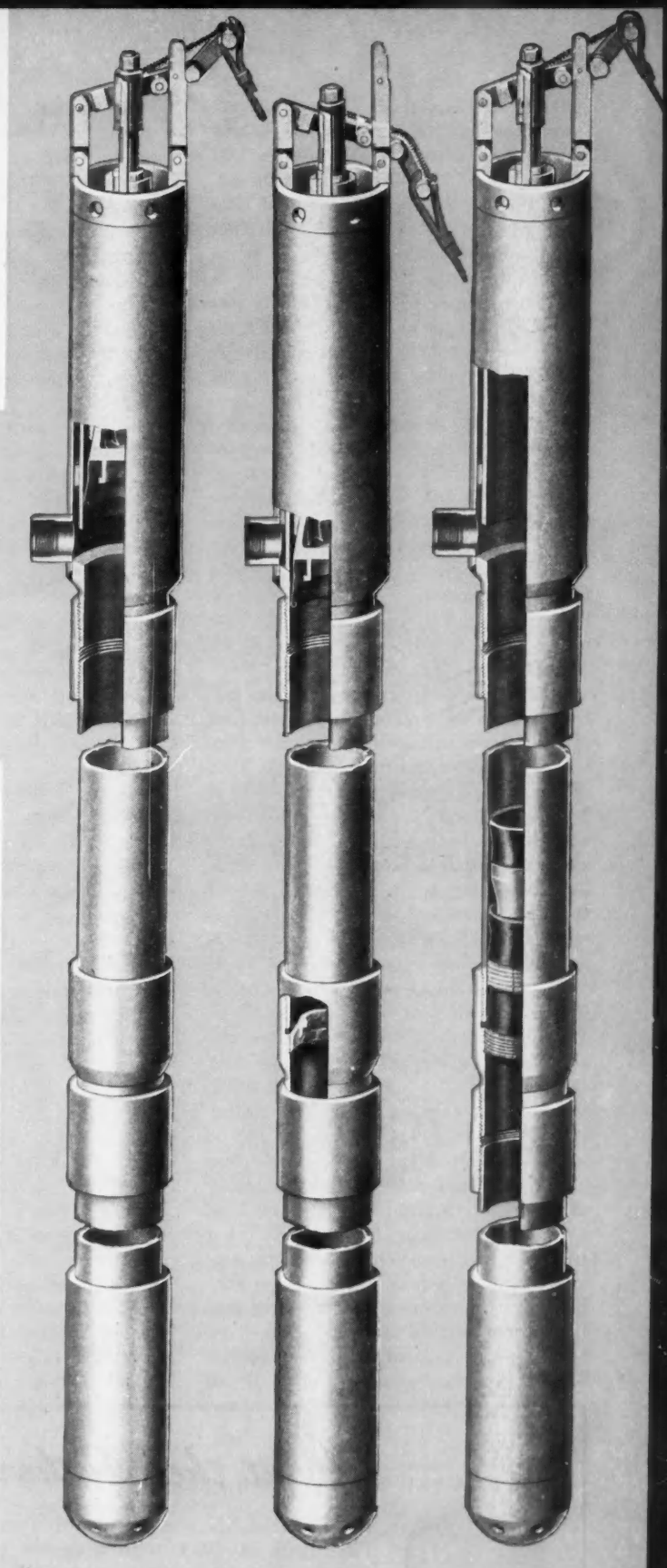
Four and one-half-inch API full hole connections were used throughout the entire string for the taper joints, while the semi-permanent connection between the drill collar body and the subs on the replaceable end collars was a 4½-inch full hole connection one inch longer than standard length. All threads on the six trial collars were hobbed on a thread miller and checked with hardened and ground gauges. All collar bodies, both for the bucked-on replaceable end collars and those equipped with tool joints, were machined from 30-foot standard length collar blanks.

From February 12, 1948, to July 1, 1949, this string of collars was used to drill more than 32,000 feet of 7⅞-inch hole in eight different wells. Actual time on bottom at rotary speeds ranging anywhere from 55 to 60 revolutions per minute amounted to almost 4000 hours. This represents approximately 15 percent of the total footage and almost 50 percent of the total drilling time on these wells. The weight carried on the bit averaged around 25,000 pounds.

In the course of drilling these eight wells, seven failures occurred in the taper joint connections of the bucked-on replaceable end subs. Five of these were pin failures and two were box failures. In addition to these actual failures, one box-and-pin sub was removed from service on the fourth well because of O.D. wear. All of these subs were removed and replaced on the rig without any difficulty.

Two of the pin failures were experienced on the third well after drilling more than 10,000 feet of hole in about 1200 hours, and two more occurred on the fourth well after about [illegible] feet and 2400 hours. All four of these failures were typical fatigue failures, but the striking feature about them is that they occurred slightly forward of the mid length of the thread. As a result there was enough engagement in the stub of the failures to hold the string together until they were discovered in coming out

BROWN METHOD OF CEMENTING CASING



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3 NEW TYPE PLUG

Equipped with hold down slips, the plug provides a back pressure valve whenever and wherever needed, eliminating necessity of maintaining pressure on casing string after plug has stopped. When stopped in the landing collar, located desired distance off bottom in the casing string, the hold down slips make it impossible for the back pressure of the cement column to force the plug upward in the casing string. The plug is made entirely of drillable material.

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of the hole. Thus, they were not the occasion for any fishing jobs as would have been the case if the failures had taken place at the last engaged thread. The fifth pin failure, however, did take place at the shoulder fillet, but the string below the break was fished without any difficulty.

The two taper joint box failures occurred in the fifth and eighth wells after about 2400 and 4000 hours, respectively. Both were typical last enaged thread failures.

During the course of the foregoing operations, all semi-permanent connections were broken out twice and all replaceable end subs subjected to a complete over-all inspection by magnafluxing, once after the first two taper joint pin failures were discovered in the third well, and again after the occurrence of the other taper joint failures in the fourth well. No other cracks or service defects of any nature were found.

In reassembling the replaceable end collars after the first magnafluxing, four of the semi-permanent connections were left open slightly at the shoulders. Two of these were double pin subs with a 1/16-inch standoff and the other two were box-and-pin subs, one with a 1/16-inch standoff and the other with .005-inch, respectively. Five or six days later the string was re-examined to determine the effect of leaving the four semi-permanent connections unshouldered.

The box-and-pin sub with the .005-inch standoff was unscrewed without any difficulty and found to be undamaged. One of the double pin subs with the 1/16-inch standoff was also removed by unscrewing, but due to the fact that it had already galled from being run in an unshouldered condition, it was impossible to remove it without considerable damage in addition to what it had already sustained in service. The other two subs with the 1/16-inch standoff, one a box-and-pin and the other a double box which were so badly galled that they could not be moved without destroying the evidence of their service failures completely, were simply cut off and the collars rethreaded. Inspection of these ends after they had been cut open disclosed galling and a complete fracture about two inches from the end of the long pin of the double pin sub, and severe galling and washing of the long pin of the box-and-pin sub.

Of course, no operator or contractor is going to run his collars with an unshouldered connection, but this does show that even the semi-permanent connection, which was otherwise practically trouble-free, can be made to fail like an ordinary taper joint unless it is shouldered up properly. And it also supports the idea that loss of contact pressure between the shoulder faces is the principal cause of joint failures.

Outside of the results obtained by leaving the four semi-permanent connections unshouldered, only one other time during the entire test period was a semi-permanent connection a cause for concern. A box member of one of the drill collar bodies which was cut off and rethreaded in a field shop after it was damaged in the open-shoulder run, sustained a last engaged thread failure in the last well. Subsequent inspection, however, revealed the field-shop cut box to be slightly off taper on the steep side besides having an excessive amount of standoff. It is possible that a combination of these circumstances developed an excessive amount of hoop tension in the box member at the end of the pin and contributed materially to the failure.

Of course, the test program was never intended as a comparative study of the performance of bucked-on replaceable end collars as against collars equipped with tool joints for replaceable ends. If it had been, the three different types of collars would have been alternated with each other over the entire length of the string in order to distribute more evenly the severity of the stresses to be imposed upon them. But the test program was designed purely and simply to determine the serviceability of the replaceable end collars under what might be considered relatively severe service in normal drilling operations. For this reason, it was merely specified that the trial collars should be used as the bottom section of an 18-collar string.

The presence of collars equipped with tool joints was simply the result of a desire on the part of the operator conducting the test to see how they would compare with bucked-on replaceable end collars for his own information. The results, however, are quite interesting.

On the six collars which were picked up on the third well, two tool joint pins and one tool joint box failed at the last engaged thread in the sixth well. As the result of a magnaflux inspection which revealed numerous fatigue cracks in the drill collar pins of the drill collar-to-tool joint connection, these collars were cut back and converted to conventional collars at that time after about 2500 hours of service. At no time had these collars been used in any position other than as the middle six collars in the string.

The other six tool joint equipped collars which had been used as the middle section in the first two wells and thereafter in the comparatively mild service of the upper section only, were magnafluxed at the same time as the six middle collars and found to have a cracked tool joint box and incipient cracks in the vicinity of the last engaged thread of the five other drill collar bodies. As a matter of curiosity, after taking into consideration the fact that the service at the top of the string would not be too severe, these were put back in service to see how long they would run. Up to the completion of two additional wells, none of the incipient cracks had yet progressed far enough to cause a drill collar body failure.

In interpreting the results obtained with the trial string, it seems safe to say that the replaceable end drill collar with the bucked-on subs has demonstrated its effectiveness as a method for combating the problem of joint failures. True enough, the idea of using replaceable end subs does not, of itself, eliminate joint failures, but it does afford a reliable method for renewing the taper joints right on the rig without any loss of collar length by cutbacks, and also without any special equipment or supervision. This, in turn, eliminates unnecessary trucking expense and keeps the collars in service where they belong.

But in addition to these advantages, the size of the replaceable end subs, and the relative ease of handling them, makes it possible to improve their quality, and that of their taper joints as well, by performing operations on them that could not be conveniently performed on a full length collar. And finally, when and if taper joint failures do occur, the only thing that has to be transported to the shop for rethreading is the replaceable end itself.

About the Author

B. E. CURRAN was graduated from the University of Pittsburgh in 1934, with a degree in petroleum engineering. After four years with the Venezuela Gulf Oil Company near Lake Maracaibo he returned to the U. S. and for three years taught petroleum engineering at the University of Pittsburgh, then became chief petroleum engineer for Kingwood Oil Company, working in the Illinois Basin and Mid-Continent areas. Since leaving Kingwood he has been with Spang-Chalfant division of The National Supply Company, where he now holds the position of assistant director of research. He continues to instruct a course in petroleum engineering at University of Pittsburgh.

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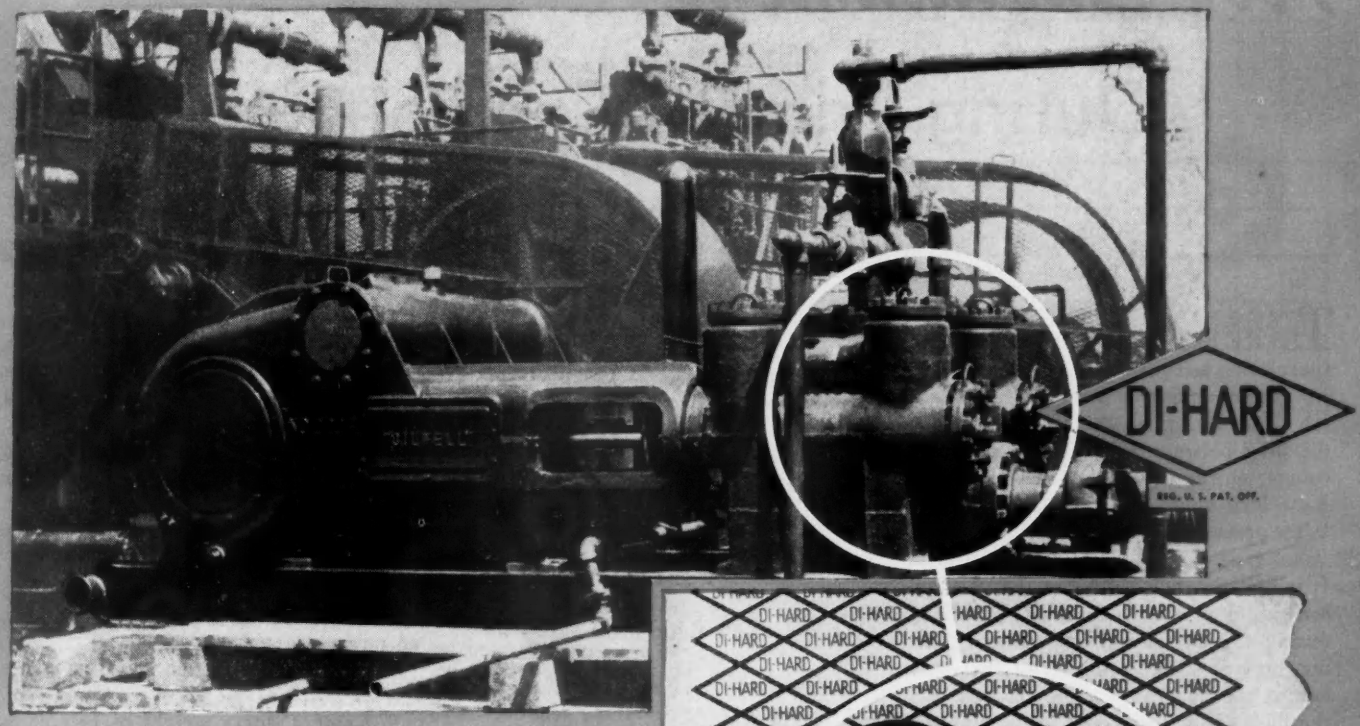

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Air Entrainment

During Primary Cement Jobs

By WALDO GROSSMAN
Halliburton Oil Well Cementing Company

THE AUTHOR discusses, and analyzes mathematically, the maximum volumes of air which may be trapped under all conditions of cementing and develops the conclusion that any air trapped below the top plug may be considered of small moment.

THERE has always been more or less speculation as to the amount of entrained air accompanying a primary cementing job. This air, after the introduction of the plug between mud and cement, becomes entrapped and compressed to some final volume.

To prevent air entrance, a plug container type cementing head can be used. It is built in such a manner that the top cementing plug is held inside the head during the circulation and cement mixing process. The fluids enter the head below this plug. It is then lowered into the fluid column by removing a supporting pin. Fluids pumped into the head are then directed above the plug, rather than below it. Consequently, the action is continuous as it is not necessary to remove the head from the casing for installation of the plug.

A non-plug container head is primarily a swage or reducer designed to provide two-inch pipe connections to the various sizes of casing. With it in use, it is necessary to unscrew all or part of the head to insert the top plug, after the cement has been mixed and pumped into the casing.

During the time the cementing head is open, the column of fluid inside the casing is exposed to the atmosphere. The cement slurry inside the casing is ordinarily heavier per unit volume than the circulating fluid (rotary drilling mud). Consequently, the cement slurry will fall to a point where the fluid inside the casing balances that in the annulus. Since the top of the casing is open to the atmosphere, air will be drawn in and will fill that portion above the cement slurry level.

The effect of this volume of air upon the resulting cement job has been the subject of much discussion. It is believed that the accompanying analysis will show that most fears for adverse results are groundless.

In making the mathematical calculations, the following assumptions and conditions were used:

1. The maximum possible quantity of air enters the casing before the top plug is inserted.

2. All of the air remains below the top plug and above the cement slurry at all times.

3. No channelling occurs, either inside the casing or in the annulus section.

4. Compression of air is in accordance with Boyle's Law, i.e.:

$$V_2 = V_1 \left(\frac{P_1}{P_2}\right)$$

V_2 = Final compressed volume.
V_1 = Original volume.
P_1 = Original pressure, absolute.
P_2 = Final pressure, absolute.

5. Solubility of entrained air is not considered here as being a factor in calculations. The plug is considered as tight so there is no contact between air and mud or water. Temperature changes are speculative and have a small effect on compression results. If air entered at 72° F. and heated to 144° with no loss to surroundings, a 15-foot compressed height would increase to 17 feet.

6. Atmospheric pressure of 15 pounds per square inch. (No allowance made for difference of pressure at surface and that at fluid level of cement slurry inside casing.)

7. Inside diameter of casing is uniform; consequently, volumes of air may be measured in linear feet.

8. The bore hole is of uniform diameter.

9. Cement slurry weight of 16 pounds per gallon.

10. Mud weight equivalent to water or 8.33 pounds per gallon. This condition will permit the entrance of the greatest volume of air for a given amount of cement.

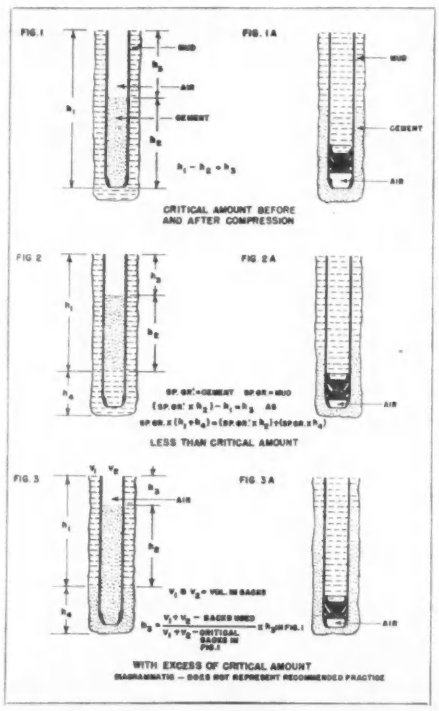
The volume of air drawn into the pipe just before placement of the final plug may vary depending upon the time consumed, etc., but can be figured as an example for a maximum possible amount, produced by a definite or critical weight of cement slurry.

For this condition the casing and hole are comparable to a U tube with immiscible fluids of different density. The maximum volume of air drawn in will follow the amount of cement slurry necessary to balance the other mud filled leg of the U tube, with the slurry just at the point of passing under and up this leg. The mud filled leg is stationary, or the same height with critical amounts of cement, or less, because no change in length of this leg can take place with the mud overflowing.

If more than the critical volume of cement is used, then both legs tend to fill and the air drawn in decreases. The cement level or height in both pipe and annulus will be an unknown quantity, unless as stated, the annulus is considered as a definite size and volume. It can be shown, however, that a large unknown factor has quite a small influence on results.

Any conditions below the critical amount of cement will also produce less air entrainment than the critical and can easily be calculated.

Taking the critical amount and know-



ing the depth of pipe to be set the weight of mud and cement slurry furnishes enough data to calculate the height of a cement column necessary to balance the mud leg. The height times Sp. Gr. of one leg is equal to the height times Sp. Gr. of the other. Thus, with 300 feet of pipe and mud of 8.33 pounds (Sp. Gr. = 1.0) and h feet of 16 pound cement (Sp. Gr. = 1.92) figures as follows—

$300 \times 1.0 = 1.92\ h$

$h = 156'$ of cement, the critical amount.

If this all descends, the void space above of $300 - 156 = 144$ feet will be filled with air. With 13⅜ pipe @ .7642 sacks per foot 120 sacks would be required. A 20-inch diameter annulus holds 1.0963 sacks per foot, or .9122 foot per sack. Sixteen pound cement = .833 pound per foot.

With half this amount of cement or 78 feet in the pipe, the equivalent mud column is 78×1.92 or 150 feet. The equivalent amount of mud overflows from the mud leg. Then $150 - 78 = 72$ feet of void space or air above the cement. Under the cement in the same leg will be $300 - (78 + 72) = 150$ feet of mud. Thus, the 78 feet of cement and 150 feet of mud in one leg are balanced by 300 feet of mud in the other. In this manner, any amount of initial air, considered as a maximum, is calculated, up to and including the so-called critical amount on any job.

Taking the 144 feet of air, by the time it reached bottom, the 120 sacks would all be in a 20-inch diameter annulus, which calculates to 109.5 feet in height, with an overlay of 190.5 feet of mud or water. Then $109.5 \times .833 + 190.5 \times .434 =$ 174 pounds pressure. $144 \times \frac{15}{189} = 11.4$ feet of compressed air. (See curves A and B Figure 4.)

If the annulus deviation were such that the cement filled up only one-half as high, the compressed air shows to be 12.9 feet. Both of these figures are the maximum possible amounts of entrained air.

With more than the critical amount of cement, air entrainment is also less. The calculation for original air is approached somewhat differently. First, volumes of both casing and annulus are each figured as sacks of cement and expressed as a total volume. Then the total volume less the volume of cement used in sacks, divided by the total volume less the critical volume of cement in sacks, multiplied by the height of air from the critical volume, equals the height of air corresponding to cement used. Or, expressed mathematically: $\frac{V_t - V_s}{V_t - V_c} \times h_c = h_s$

where

V_t = total volume

V_s = volume of cement used, in sacks

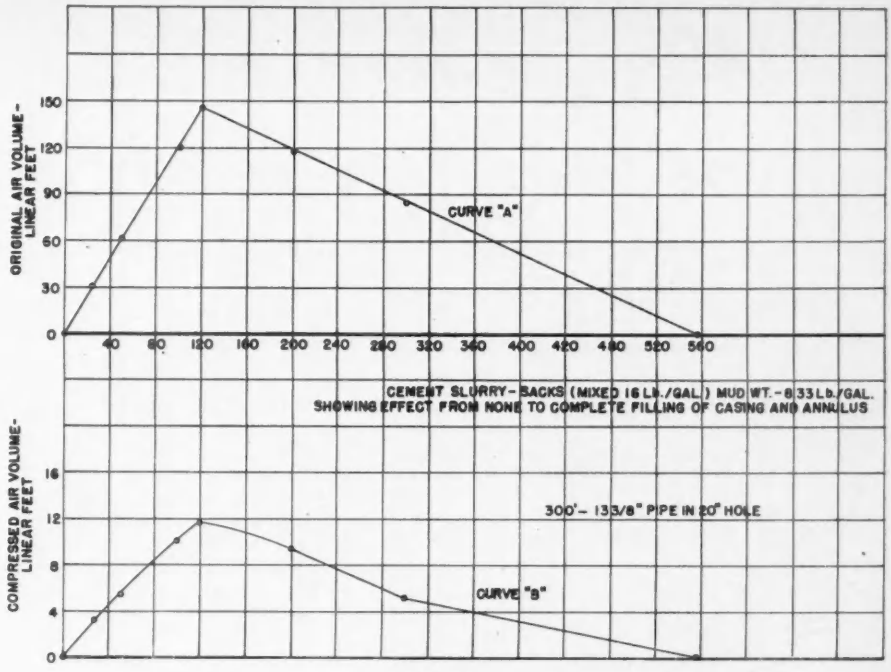


FIGURE 4

V_c = critical volume of cement, in sacks

h_c = height of air from critical vol.

h_s = height of air corresponding to cement used.

For example, with the above pipe and hole conditions, 200 sacks of cement are to be used.

300 feet of pipe = $300 \times .7642 = 229.26$ sacks

Annulus = $300 \times 1.0963 = 328.89$ sacks

Total = 558.15

Then $\frac{558.15 - 200}{558.15 - 120} \times 144 = 117.8$ feet of entrained air.

If the plug is to be pumped to 20 feet from the bottom, this space equals 15.28 sacks, placing 184.7 sacks in the annulus.

184.7 sacks = 168.5 feet of cement and 131.5 feet of mud to compress the air.

$168.5 \times .833 + 131.5 \times .434 = 197.3$ pounds pressure.

$117.8 \times \frac{15}{212.3} = 8.32$ feet of compressed air below the plug. Actually, this would mean a slightly greater cement height in the annulus but is accurate to about 2 percent. A mud heavier than water would reduce the air volume still more.

If enough cement were used to just fill the annulus and leave 20 feet in the pipe, it would require about 345 sacks.

Then $\frac{558.15 - 345}{558.15 - 120} \times 144 = 56.9$ or 57 feet of entrained air.

$300 - 20$ feet of cement would then compress the air or $280 \times .833 = 233$ pounds.

$56.9 \times \frac{15}{248} = 3.44$ feet of compressed air below the plug.

With 10,000 feet of pipe, 16-pound cement and 10 pound mud, (1.2 Sp. Gr.) the critical volume of cement will produce a maximum volume of air as follows.

h = 6,240 feet of cement.

$10{,}000 \times 1.2 = 1.92\ h$

$10{,}000 - 6{,}240 = 3{,}760$ feet of air.

Using 5½-inch, 23-pound pipe @ 9.25 feet per sack, the critical volume of cement is 641 sacks. The hole is 8½ inches with annulus @ 4.8 feet per sack. The plug is to be left 60 feet off bottom.

Sixty feet of pipe holds 6½ sacks, leaving 634½ sacks in the annulus, or 3,045 feet of cement. This leaves 2,985 feet of cement for compression plus 6,955 feet of mud.

$2{,}985 \times .833 + 6{,}955 \times 1.2 \times .434 =$ 6,108 pounds pressure.

$3{,}760 \times \frac{15}{6123} = 9.2$ feet of compressed air. More or less cement will result in a smaller amount. Substituting 20,000 feet of pipe, under identical conditions as above gives 9.16 feet of compressed air as the maximum amount possible.

The maximum height of compressed air with a critical amount of cement with an infinite depth of pipe will approach a value of only 16.6 linear feet.

It can be seen that under the worst conditions the maximum volume of entrained air is compressed to a small footage in both shallow and deep wells. When more or less than a calculated critical volume of cement is used, the compressed air will be much less, so that in the usual run of jobs there is no cause for alarm.

ACKNOWLEDGMENT

The writer wishes to express thanks to Halliburton Oil Well Cementing Company for permission to publish this paper.

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Drill-Stem Testing in Open Hole

By J. E. SMITH

Johnston Oil Field Service Corporation

THE practice of making drill stem tests of productive horizons or of horizons which indicate producing possibilities has become almost universal in oil well drilling operations. However, despite its widespread application, the technique is not as well known among field personnel as it should be. Such lack of the fundamental concepts of drill stem testing not infrequently results in a poor or inconclusive test despite the efforts of the service company representatives who actually run the tool. It is the writer's belief that a clearer understanding of factors which must be considered before and during the making of a drill stem test will result in assuring a larger proportion of successful jobs. This is particularly true in conducting a drill stem test in an open hole where the hole must first be properly conditioned, which is the responsibility of the operator and the drilling crew.

The Principle of Drill Stem Testing:

The formation tester is designed for simplicity and accuracy. The principle is to relieve the zone being tested of hydrostatic pressure of the column of drilling fluid present in the open hole and to subject the formation to atmospheric pressure through the drill stem upon which the tester is run. The entrance into the testing tool of the fluid from the test zone thus packed off and relieved of hydrostatic pressure is controlled by a series of valves of which the testing tool is composed.

Procedure of Drill Stem Testing:

When the work program is written for a well to be drilled, it is well to consider the size hole that is to be drilled relative to making drill stem tests. If a large diameter hole is to be drilled it is advisable to reduce the size of the hole when testing depth is reached. Best results are obtained in sand producing areas testing in holes of 6¾ to 8 inches in diameter. Drilling of smaller diameter holes than 6¾ inches requires the use of smaller bits and tools and progress is slower. In holes exceeding 8 inches in diameter, difficulty is encountered in effecting a pack-off, with the ratio of packer failures increasing with hole size. The open hole wall packer is usually one inch less in diameter than the diameter of the hole in which the pack-off is to be effected. However, packers are available in sizes ranging from 3⅛ through 11¼ inches in diameter to run in the various size holes drilled.

Selection of a Packer Seat:

In a drilling well when a zone is encountered and it is desired to make a drill stem test, careful consideration should be given to the selection of a packer seat. The packer seat should be based upon the best formation possible immediately above or preferably in the top of the zone to be tested. Shale is usually found immediately above a possible producing zone. Generally the shale is not of sufficient hardness to permit the packer to effect a pack-off. Experience has demonstrated that hard or firm non-fractured formation, such as sand, shell, lime or chert provides the most effective packer seat.

Selecting the Amount of Hole to Test:

In selecting the amount of hole to test, it is important to give due consideration to the fact that a more conclusive test can be obtained by testing small sections. In relatively thin sand sections such as are encountered in Southwest Texas and the Texas-Louisiana Gulf Coast, the test zone is frequently two to ten feet. By testing the shorter interval gas/oil and water/oil contacts are definitely established. The operator is then governed accordingly in completing the well and controlling the gas/oil ratio and cementing off the water-bearing formation.

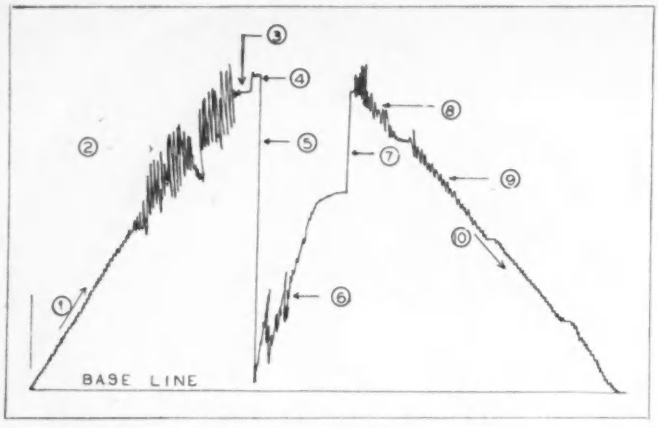
When producing zones of greater thickness are encountered, it is then feasible to test more hole per test. Where large zones are to be tested it is well to consider that the drilling fluid in the hole below the packer must pass through the testing tool into the drill pipe before formation fluid may enter.

Should the volume of drilling fluid below the packer be too great, it will fill the pipe to such height that the pressure of the formation fluid may not be sufficient to effect an entrance against the back pressure of the column. The amount of hole to test can be more accurately determined by the field personnel after due consideration of characteristics of the formation to be tested, as to permeability, porosity and expected bottom-hole pressure.

Conditioning the Hole and Drilling Fluid:

It is imperative that the hole and drilling fluid be properly conditioned prior to making a drill stem test. Fully 50 percent of all failures to obtain a successful and conclusive test are due to condition of the hole and improperly conditioned drilling fluid.

1. A full gauge hole has no tight spots to interfere with the free entry of the packer. When it is necessary to force or spud a packer through a tight section of hole, it will scrape off the mud sheath, pushing the debris to the bottom of the hole opposite the test zone. When the tester is opened, this same heavy material enters first and has a tendency to plug the perforated anchor and orifices in the testing tool. And even though the anchor or tester does not completely plug, the heavy material will obstruct the free entry of fluid into the tester and drill pipe.
2. The drilling fluid must of course be of sufficient weight to control the producing zone and the viscosity low enough to maintain fluidity. Be-



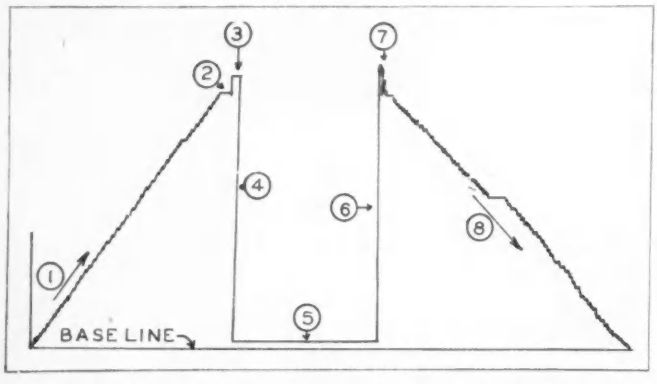


FIGURE 2. 1—Running in hole. 2—Hydrostatic pressure (weight of mud column). 3—Squeeze created by setting packer. 4—Opened tester, releasing pressure below packer. 5—Flow period, test zone open to atmosphere. 6—Closed tester and equalizing hydrostatic pressure below packer. 7—Pulled packer loose. 8—Pulling out of hole.

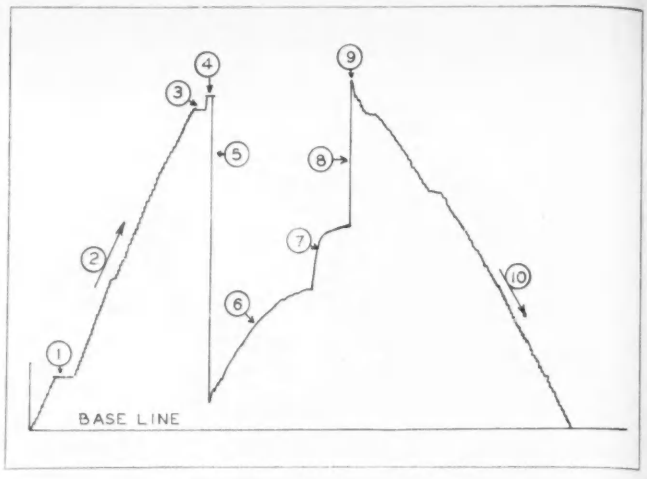


FIGURE 1 (above left). 1—Running in hole. 2—indicates bad hole condition, scraping wall cake. 3—Hydrostatic pressure (weight of mud column). 4—Squeeze created by setting packer. 5—Opened tester, releasing pressure below packer. 6—Indicates plugging of perforator anchor or tester. 7—Closed tester and equalizing hydrostatic pressure below packer. 8—Indicates swabbing due to bad hole condition. 9—Indicates less swabbing, better hole condition. 10—Pulling out of hole.

FIGURE 3 (above right). 1—Putting water cushion in drill pipe. 2—Running in hole. 3—Hydrostatic pressure (weight of mud column). 4—Squeeze created by setting packer. 5—Opened tester, releasing pressure below packer. 6—Flow period, test zone producing into drill pipe. 7—Shut in pressure, tester closed immediately above packer. 8—Equalizing hydrostatic pressure below packer. 9—Released packer. 10—Pulling out of hole.

fore pulling out of the hole to make a drill stem test, circulation should be maintained for sufficient time interval to insure the removal from the hole of cuttings and heavy or viscous mud which will interfere with the entrance of fluid into the tester. In many instances an extra hour consumed in circulating the drilling fluid will save five or six hours rig time that would otherwise be spent in making an unsuccessful trip in the hole with the tester.

Fluid Cushion:

Fluid cushion, sometimes called water cushion or water blanket, is the insertion of water in the drill pipe and is used to advantage when testing at extreme depths to protect the drill pipe from collapse; and also, when testing high pressure formation to cushion the entry of fluid from the producing zone, permitting the formation to start producing at a lower rate and increase as the fluid cushion is displaced. Thus, the shock occasioned by the sudden release of pressure below the packer is reduced. In a loose or unconsolidated sand body that is likely to break down and slough off when exposed to the differential in pressure occasioned by opening the tester, fluid cushion is used to advantage.

Careful consideration should be given to the amount of fluid cushion used, as the interposed fluid has to be lifted by the formation pressure when the testing tool is opened.

Mechanics of Drill Stem Testing:

The testing tool consists of four valves, the packer, perforated anchor or tail-pipe and depth pressure recording device assembled in the order named. The tester is assembled as a unit and connected to the bottom of the drill pipe. The tools thus assembled are lowered into the hole on the empty drill pipe or in event a fluid cushion is used, the partially empty drill pipe. When the zone to be tested is reached the packer is expanded against the wall of the hole by applying the weight of the drill pipe. With the packer expanded a pack-off is effected isolating the test zone from the hydrostatic pressure of the mud column.

The valves of the tester (all of which are controlled by the operator) are opened. The test thus being relieved of the hydrostatic pressure by action of the packer is free to produce under its own pressure through the drill pipe.

Immediately following the opening of the tester and during the test period the fluid level in the annular space should be closely observed. When the tester opens and during the test period the fluid level in the annular space should not fall. By this fluid level remaining constant a positive pack-off is indicated and also that the fluid entering the drill pipe is coming from the test zone below the packer. If the fluid level in the annular space should drop suddenly, the packer is not holding. If this occurs the drill pipe must be picked up immediately to automatically close the tester to prevent the drilling fluid from equalizing by filling the drill pipe. It is advisable to attempt to reset the packer as there is a possibility that it may get a seat and effect a pack-off.

With a pack-off effected the tester is left open for the time interval desired. This time interval is referred to as the flow period. At the conclusion of the flow period which is usually 10 to 30 minutes, the shut-in pressure valve in the tester assembly is closed. By closing the tester the formation pressure rapidly builds up and reaches equilibrium. This is referred to as the shut-in period. The time interval required for the formation to reach equilibrium varies from 10 to 30 minutes, depending on the permeability of the formation being tested. It is important to allow sufficient time for

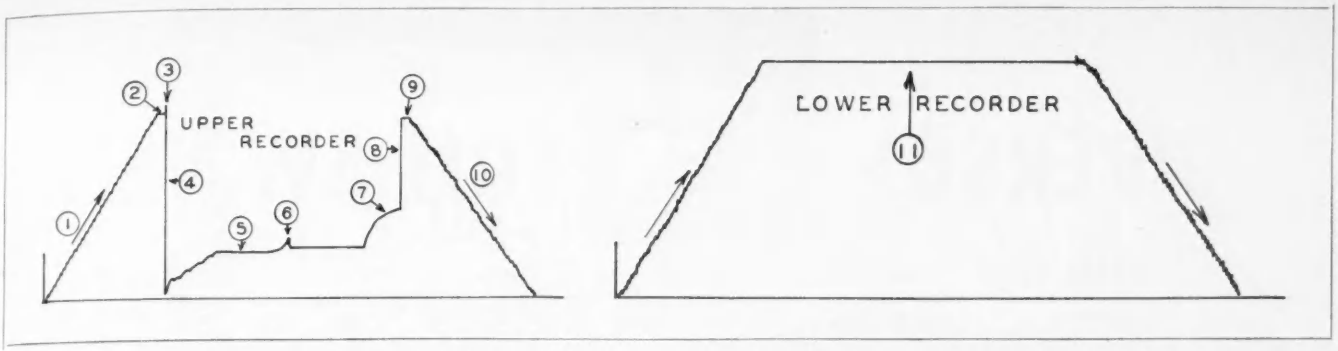


FIGURE 4. Testing between packers. 1–Running in hole. 2–Hydrostatic pressure (weight of mud column). 3–Set packer. 4–Opened tester, releasing pressure between packers. 5–Test zone flowing. 6–Rise in pressure due to closing in to change chokes. 7–Shut-in bottom hole pressure. 8–Equalizing hydrostatic pressure between packers. 9–Hydrostatic pressure at conclusion of test. 10–Pulling out of hole. 11–Lower recorder, below bottom packer, shows no drop in pressure, proves bottom packer is holding.

the shut-in period in order that a correct pressure measurement be obtained.

At the conclusion of the shut-in period the drill pipe is picked up to open the equalizing valve which allows the hydrostatic pressure of the mud column to be applied to the formation below the packer, facilitating the removal of the packer from the seat by equalizing the pressure above and below the packer.

The drill pipe and tester assembly are removed from the hole. As the drill pipe is removed, the fluid recovered on the test is observed by taking samples from each wet sand.

At the bottom of the perforated anchor is the depth pressure recording device. This instrument is also referred to as a bottom-hole pressure gauge. The purpose of this device is to measure the pressure in pounds per square inch during the entire testing operation. It consists of a calibrated spring which is compressed by the pressure in the well. The pressures are recorded on a sensitized paper chart. The chart is revolved by a clock, and if desired, pressures in relation to time may easily be computed.

The depth pressure recorder furnishes a graphic record of the entire testing operation. Without this record of pressures and pressure changes, it would in many instances be impossible to interpret conclusively the results obtained on some drill stem tests.

At this point it will be well to consider the pressure factors most commonly used to interpret a drill stem test. Figure 3 shows a reproduction of the pressure recorder chart from a drill stem test. Part 1 shows the pressure buildup as the tester is lowered into the hole. This pressure buildup is the weight of the mud column. Part 2 is the hydrostatic pressure (weight of mud column at the bottom of the hole). Part 3 is the squeeze created by expanding the packer against the wall of the hole. Part 4 is the sudden release of pressure below the packer occasioned by opening the tester. Part 5 is the flow period of the test, fluid is entering the empty drill pipe from the formation below the packer. The pressure changes are recorded and the buildup in pressure is checked against the amount of fluid recovered in the drill pipe. At the conclusion of the flow period the tester is closed immediately above the packer. Part 6 is the buildup of formation pressure and is referred to as the shut-in pressure. The buildup is rapid due to the small volume of the area below the packer. Usually in 15 to 30 minutes the formation pressure will build up to its maximum pressure. This is commonly called the static bottom-hole pressure and is reached when the pressure in the well bore is in equilibrium with the pressure in the surrounding formation. A knowledge of the flowing and static pressure is essential in reservoir engineering work and in computing the productivity index, and these data are used in reserve estimates and proration purposes. Part 7, hydrostatic pressure of mud column, is equalized above and below the packer, killing the producing formation and relieving the packer of differential in pressure. The equalizing of pressure facilitates the removal of the packer from the seat. Part 8 is the weight of the mud column at conclusion of the test. Part 9 is the pressure decreasing as tester is removed from the hole.

Dry Test

In Figure 1, the tester or perforated anchor is obviously plugged. The fluid recovered on this test amounted to 90 lineal feet, the maximum formation pressure recorded is 1860 pounds per square inch. The observed surface blow was very light for ten minutes.

If the pressure recorder had not been used or had failed to function, the zone tested might have been passed up as dry.

Figure 2 is an example of a dry test. The zone tested as shown by the pressure measurements failed to give up fluid. This is a conclusive test as shown by the drop in pressure to 30 pounds per square inch when the tool opened. By the pressure remaining at 30 pounds per square inch during the entire test period it is evident that the formation being tested is unproductive.

Figure 4 reproduces the two pressure charts taken from a test between packers. This type of test is often referred to as a "Straddle Test." It is used extensively both in open hole and inside casing or liner. The purpose is to make a drill stem test with the test zone packed off above and below. The upper pressure recording device is placed between the upper and lower packer opposite the test zone and measures the pressure changes in the test zone. The lower instrument is placed below the bottom packer and is blanked off from the test zone, the purpose being to determine the effectiveness of the pack-off of the bottom packer.

The illustrations are presented to indicate the importance of depth pressure measurements and their influence in interpreting the results of the test as to productivity of the test zone. It also is a graphic record for "on the job" observation as to the conclusiveness of the drill stem test.

Because of the economic factor involved, every effort should be made by field personnel and service companies to obtain conclusive results when making a drill stem test. It is obviously poor business for an operator to spend a substantial sum in cutting a hole and not to adopt the necessary measures indicated in order to obtain an accurate test of the prospective pay zone. Only by a proper understanding of the functions and application of the testing tool can an operator obtain the necessary information concerning the possible productivity of his well the drilling of which, up to the point of testing, has cost him a substantial sum. Furthermore, a successful drill stem test will determine the wisdom of additional expenditures involved in setting casing and additional rig time required to make a final production test of the well.

ACKNOWLEDGMENT

The above article was prepared for WORLD OIL from notes used in a presentation of the subject before the Kansas Section, AIME, at Wichita, Kans.

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- Packing assembly fast and easy to replace—fits either way, goes in without disconnection of gooseneck or hose.
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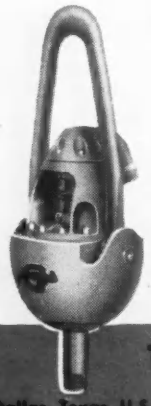

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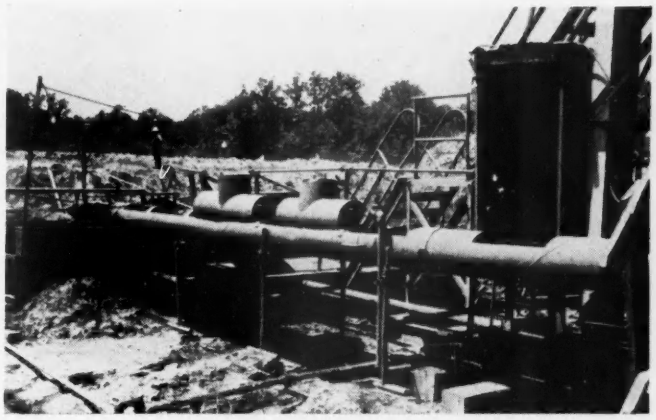
HOW TO—Build Unitized Mud Return Trough



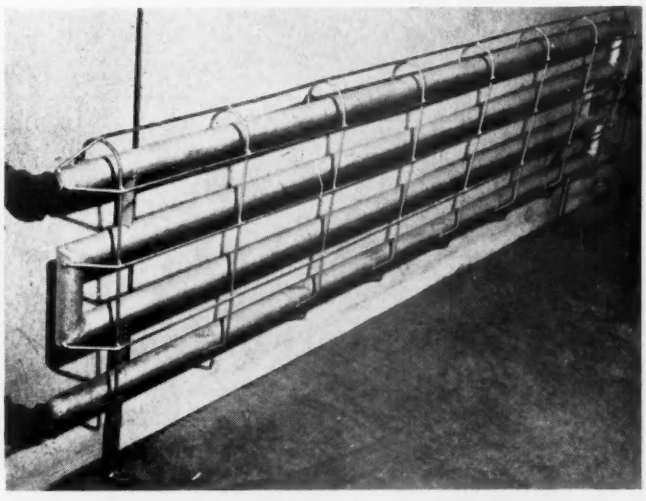
Getting drilling mud from the well-head back to the shale shaker is no unusual problem, but building equipment to handle it efficiently, and equipment that can be easily assembled and knocked down, is something worthwhile. This mud return trough was made from salvaged 20-inch casing of the spiral-weld type. It extends parallel to the V side of the derrick for about 60 feet. A standard eight-inch line discharges into this elevated return trough.

The trough illustrated is made up in three sections, each about 20 feet long. The upstream end of each section has been belled out so that the adjacent upstream section could be slipped inside it for one or two inches. These sections were held together on either side of the casing by clamps, each consisting of a short piece of flat plate steel welded to the outside and bent so that it would accept a bolt. By tightening the bolt, the two sections can be drawn together to make a fairly tight fit.

To make the flow of mud visible, slots were cut in the pipe at various points. The upper one-third of the trough was removed by a cutting torch so that the casing was adequately supported when filled with drilling fluid. Chemical treating containers were made from short sections of this same size casing with a dome welded to each to serve as a cover. These containers were fitted with control valves, and placed in the trough as illustrated to simplify the mud-treating problem.

The trough was supported by vertical legs and cross pieces of two-inch pipe. Footing pieces welded to the bottom of each leg held the support in a vertical position.

HOW TO—Fabricate a Change Room Heater



(Courtesy Lincoln Electric Company)

The cold winter months make a steam heater welcome on any drilling rig. It is especially appreciated as standard equipment in the change room. Illustrated is a particularly efficient shop-made heater which takes little space and provides adequate heat.

This unit utilizes mud pump exhaust steam as a source of heat. It is made of two-inch pipe swedged down at both intake and exhaust ends to accommodate two 1½-inch ells. Horizontal run of each leg is approximately eight feet. A return bend was made by welding a short nipple to each leg as shown. In addition to the support provided by the two connections on the intake and exhaust of steam, quarter-inch steel traps welded between the unsupported legs provide sufficient strength to hold the heater in place. A right-angle bracket with holes serves as footing pieces for the strap iron supporting legs.

To prevent injury to personnel who may lean against the heater, a protective grill was made by welding quarter-inch steel rod to the heater as shown. Its shape and support is sufficient to prevent bad burns by direct contact with the hot elements of the heater.

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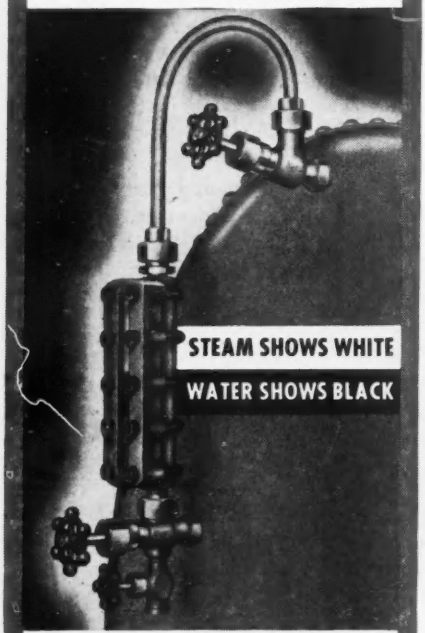

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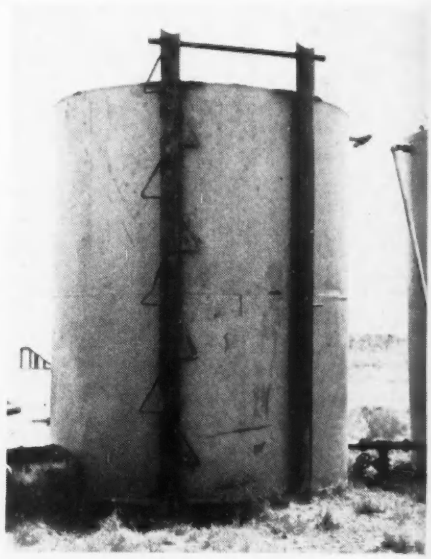
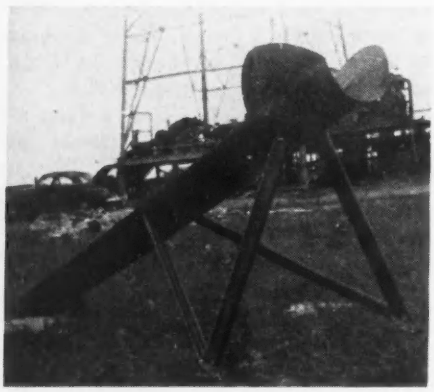
HOW TO—Improve Tank Skid Base

Portable water tanks used at the drilling well must be equipped so that they are easily loaded or unloaded from trucks and can be set up quickly at the location, yet withstand rough handling which ordinarily would cause seams to leak. One drilling contractor operating in the West Texas-New Mexico area finds it desirable to weld to each of his tanks a skid base made of two lengths of five-inch diameter pipe. The two lengths of pipe are welded to the tank at the head and bottom ends, these being the strongest points on the tank. For maximum contact with the tank rim, and corresponding strength of the welds, a semi-circular fillet of steel plate is cut out and welded to the rim of the tank head, the pipe runner then being welded to a semi-circular cut in the convex edge of the fillet.



HOW TO— Construct Slide For Drill Pipe



After a well has been completed, it is necessary to get the drill pipe down to the rack quickly and safely. A slide for this purpose may be fabricated from materials found around the yard.

A 16-foot piece of 10¾-inch casing is split down the middle except at the top 18-inch section, where the cuts from both sides come together to form semi-circles which touch each other at the top. These semi-circles are then heated along their diameters and flared out to form a "funnel" to direct the drill pipe into the channel formed by the casing.

A stand is then fabricated from three-inch and two-inch pipe welded at an angle to hold the front end over the derrick floor when the lower end rests on the walk between the pipe racks. When each joint is broken down, it is slid down to the rack where the pipe racker picks it up with the pipe buggy.

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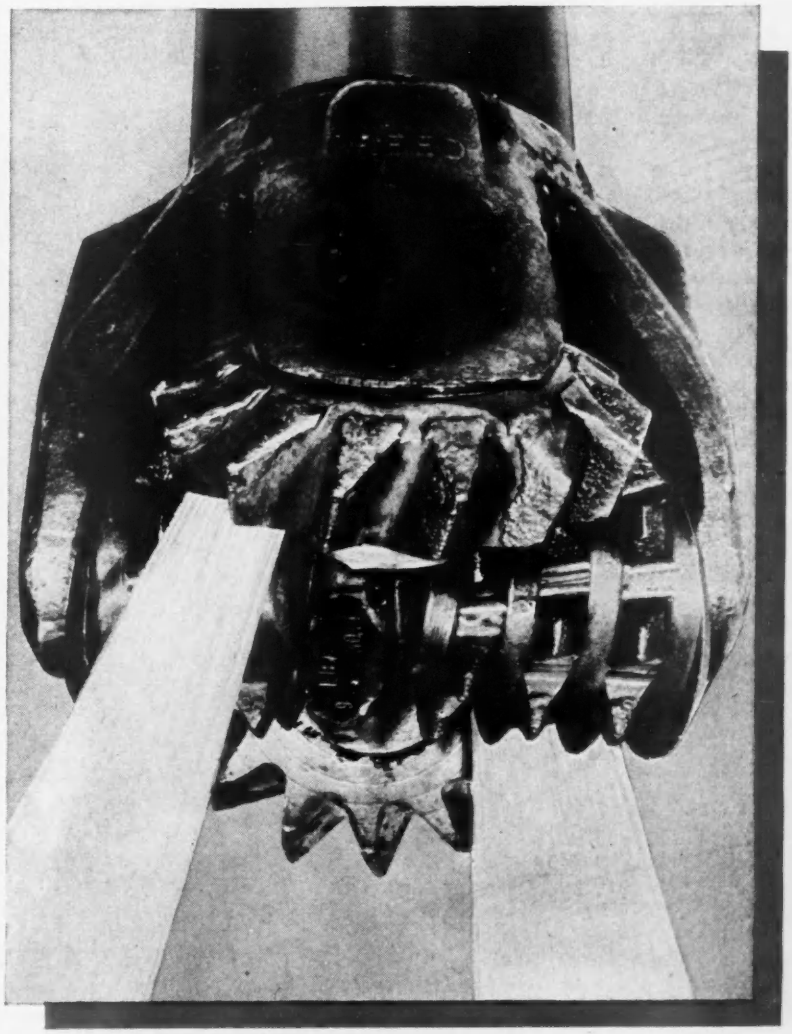
This powerful jetting action, however, is not entirely dissipated on the cutter teeth but continues on to the bottom to remove the bit cuttings rapidly from the bottom of the hole.

Reed "LB" Rock Bits, therefore, are continually cutting on new formation, and the possibility of re-cutting formations already loosened is practically eliminated.



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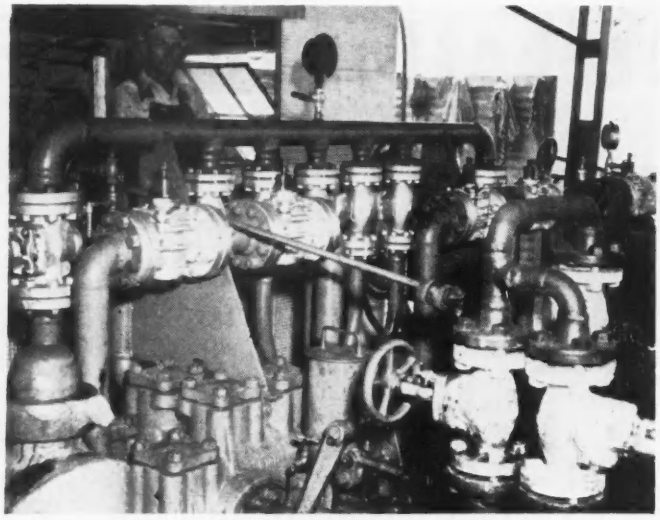
HOW TO—Compact Boiler Feed Water Control Unit



The boiler feed water control unit can be compacted into an efficient skid-mounted assembly by utilizing several space-saving construction ideas. By making this unit smaller in dimensions, not only is material conserved in fabricating the control unit, but it can be handled easier when making a rig move.

One of the outstanding space-saving features of the boiler feed water control unit illustrated is the placement of both boiler feed water pumps almost at the front of the assembly. Normally, these pieces of equipment are set farther back on the skid to make connections with the manual control valves on the feed water manifold.

In this control unit, water fed into the boilers was regulated at the boiler by the water level in each boiler. The feed water pumps maintained a predetermined pressure on the feed water system to insure flow of water into the boiler. The feed water manifold is actually supported by both pumps mounted on the unit skid. (A third auxiliary feed water pump is available in case of breakdown.) The supporting brackets for the manifold are held by the inside bolts of the valve pot covers of each pump. The pressure discharge line is welded to this support which also extends up to the manifold.

A dual valve arrangement on each pump discharge makes it possible to flow the boiler feed water either through an exhaust steam heat exchanger or direct to the boilers. The heat exchanger is supplied exhaust steam from the mud pumps. When these are not in operation, the flow of feed water can be made direct to the boilers. This dual valve system can be controlled from the same position as the needle valves controlling the flow of water to each boiler.

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HOW TO—
Use Wire Line To Rack Casing

When casing is to be racked at a new location, it usually requires a load of lumber from a yard to supply two-by-fours to separate the layers of casing. One operator in Kansas keeps a supply of used drilling line on hand and cuts it into sections to be used instead of lumber to strip the joints.

As soon as a load of casing arrives there is no delay while lumber stripping is located and brought to the location. Pieces of the used drilling line are cut in a few minutes and laid across the joints of pipe. The drilling line is solid enough to allow the pipe to be rolled freely, yet gives enough so that the pipe will stay in place.

As soon as the pipe is run, the wire lines are placed in coils and can be used on several locations.

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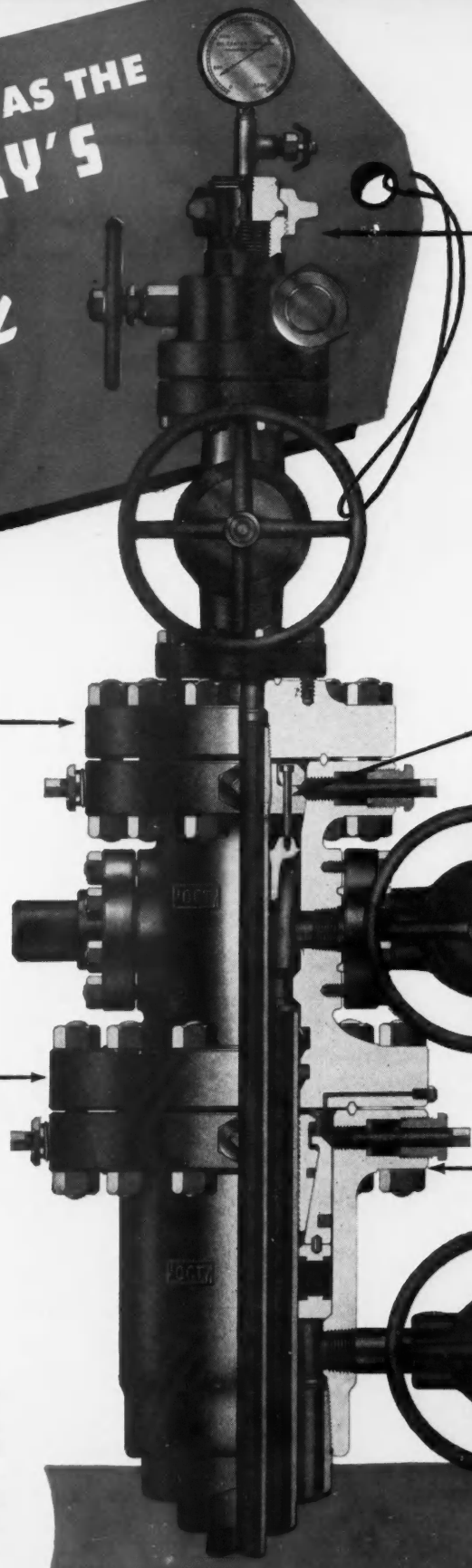

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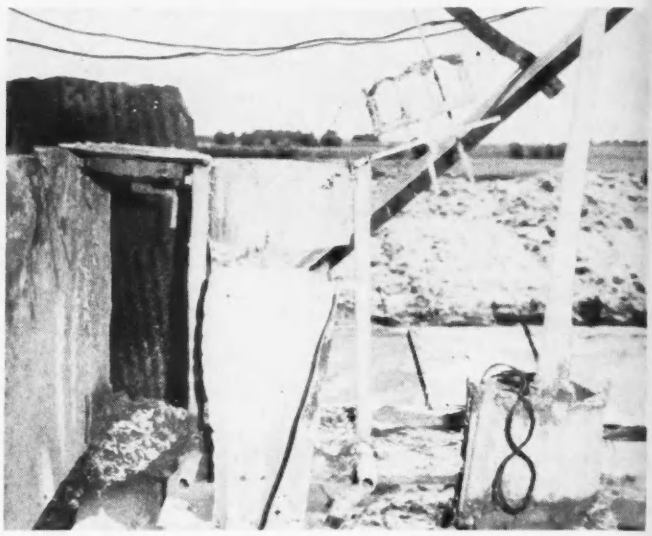
HOW TO—Wash Cable Tool Samples



On cable tool rigs, it is necessary to wash the cuttings before sacking them for the geologist. A sample washer that can be made at the well is made from scraps of one-inch pipe and a short piece of 14-inch casing with one end welded closed. The one-inch pipe is used to make the stand and has runners on the bottom to hold the sample washer upright. Pieces of sucker rod material are welded to the top of the 14-inch nipple and holes are cut into the top of the one-inch uprights so that the container can swing to decant the water.

Hinges are welded at the top of both one-inch pieces. The one on the right carries a series of brushes made by babbiting ends of sand line into half-inch nipples. The other carries the lid on which is mounted a heavy mesh screen.

In operation, a sample is caught in the sample can attached to a holder shown at the lower right. It is conveyed to the washing chamber where water is turned in with the floor hose, the brush worked, and the water decanted several times. The sample is then scooped up to the wire mesh where it is allowed to dry. This mesh is beside the bit heater and the samples dry quickly.

HOW TO—Store Winch Snatch Block

Makeshift attachments for the snatch block at the back of the truck frequently cause damage to equipment and expose personnel to needless risk. To protect equipment at this point one company has the rear member of the truck, which carries the legs of the A-frame, fitted with a heavy segment of plate, welded to the cross-member at both ends and at the center, so that two slots are provided in which the snatch block hook or a short piece of chain may be placed. This point of attachment centers the pull and avoids heavy strain on one side of the equipment. By using this point as attachment for the end of the line, the snatch block can be attached to the load to be moved, and a double purchase thus obtained.

Use of the anchor plate also allows the line to be run through the A-frame crown block and through a snatch block at truck-bed level when light loads are to be moved and it is not considered necessary to unreeve the A-frame line.

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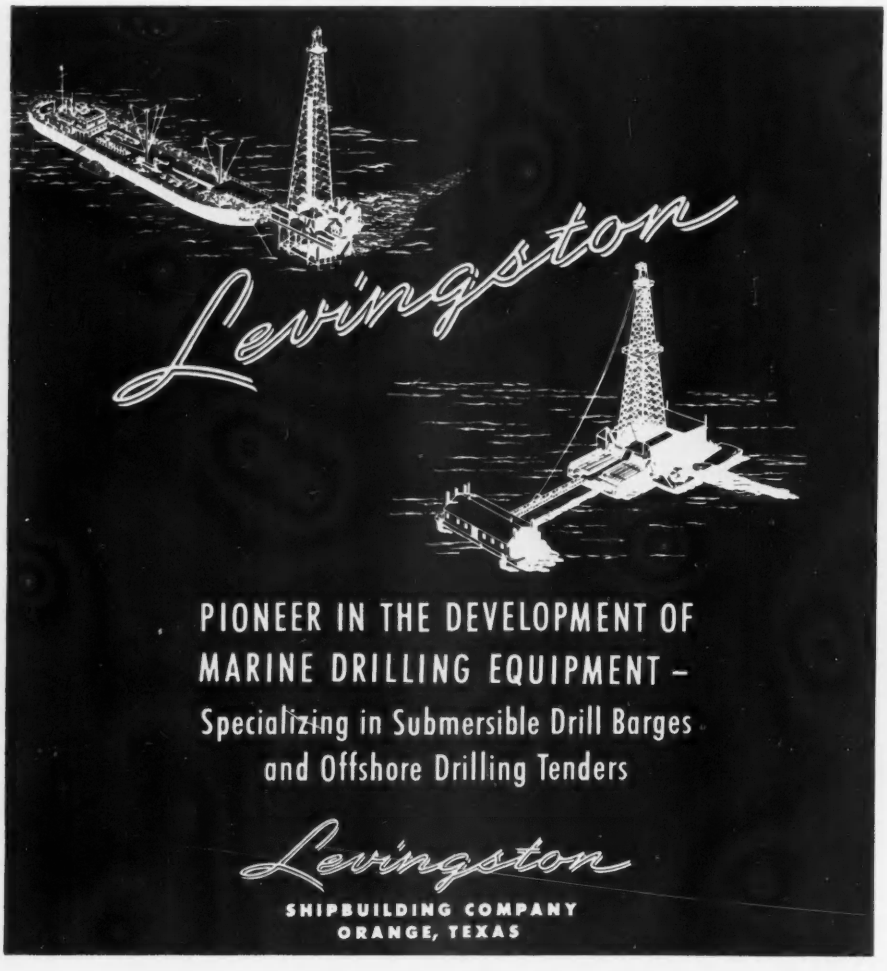
HOW TO—Rack Traveling Block

Rigging-up and tearing down on the portable, mast-equipped well pulling unit may be facilitated by providing a place for resting the traveling block when the pulling unit is moved between wells. A simple enclosure, of heavy round bar material is welded to the wellhead side and near the base of the mast. Dimensioned to accommodate the block, the enclosure illustrated projects from the face of the mast only 12 to 15 inches, and does not interfere with the movement of workmen around the well.

Also shown is the simplified method employed for holding back the block and tubing elevators when the latter are not in use, such as when bailing operations are being conducted. A short length of sand line, equipped with a loop at each end, is run through the elevator links and then hooked over a sucker rod hook welded to the base of the mast. Pulling up the block until the line is taut holds the assembly close to the side of the mast and out of the way of other well work. Sucker rod boxes were employed to good advantage in providing a convenient method of babbitting together the line when the line loops were made.



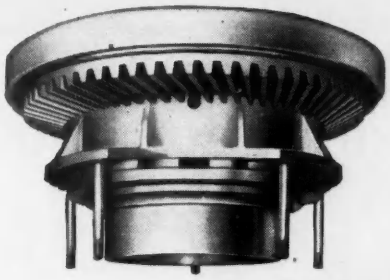
HOW TO— Hard-Surface Tool Joints

The most economical means of preserving tool joints is by means of hard surfacing. This has become an established method for making tool joints tighter and permanently stronger so that they will better resist fatigue stresses set up by the whipping action of the drill pipe. Worn joints are a source of failure.

The time to hard-surface is when wear begins to show around the collar. If this is allowed to go too far, it is necessary to place a sleeve over the joint, thus adding greatly to the cost of the operation.

A copper backup collar is placed three-fourths inch away from the edge of the box end and the gap between it and the shoulder is filled in with two passes of a mild steel electrode. A layer of hard-surfacing material is deposited until the weld is flat and level with the diameter of the joint. This is a roll welding operation, the welder performing the rolling with his left hand. The positioner is made from sucker rod and clamps on the end of the joint. The operation requires 200 amperes and approximately 50 volts.

Courtesy Lincoln Electric Company



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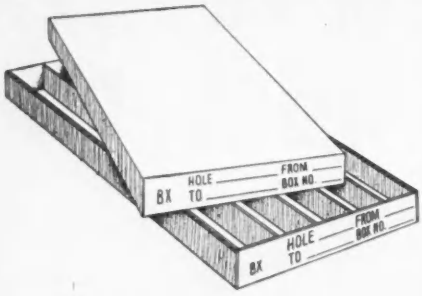

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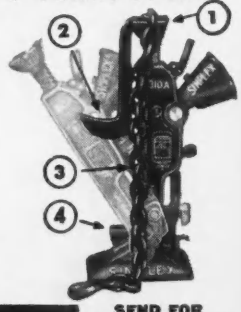

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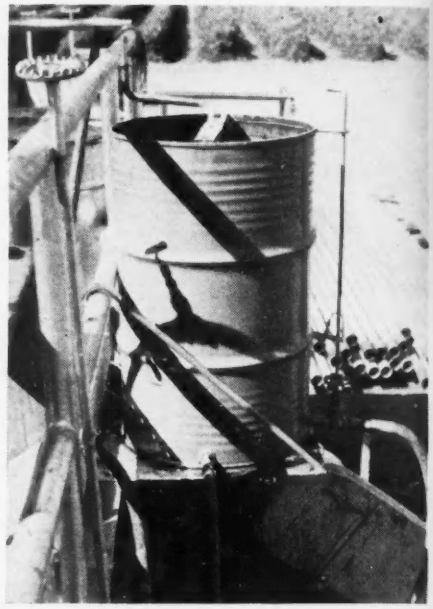
HOW TO—Build Mixing Drum Shelf



On nearly every rig there exists the problem of how to mount the chemical mixing drum above the mud ditch, out of the way of working areas or walkways, yet so positioned that mud chemicals may be added, mixed and the flow regulated from a convenient position on the derrick floor. One drilling contractor solved the problem by mounting the drum on a small square sheet steel shelf swung just outside the derrick floor railing at a convenient point above the mud ditch. The steel shelf is supported by a pair of diagonal rods welded to the outer corners of the platform and attached to the railing by hooking the rods over the lower rail of the derrick floor enclosure. The inboard side of the steel shelf is bolted to the edge of the derrick floor.

The water inlet is at the bottom of the drum, and is connected to the water line with a rubber hose. The outlet valve, positioned on the far side of the drum, is controlled by an extension handle that projects up through guides to a point above the drum top, the handle being reached easily by the man on the derrick floor. A rubber hose also is attached to the outlet valve, making it easy to direct the solution to the ditch without assembling piping. Accessibility of the unit from the derrick floor for all mixing operations, including the handling of the bulk materials, and the ease with which the entire assembly can be torn down and reassembled, make this an unusually practical type of installation.

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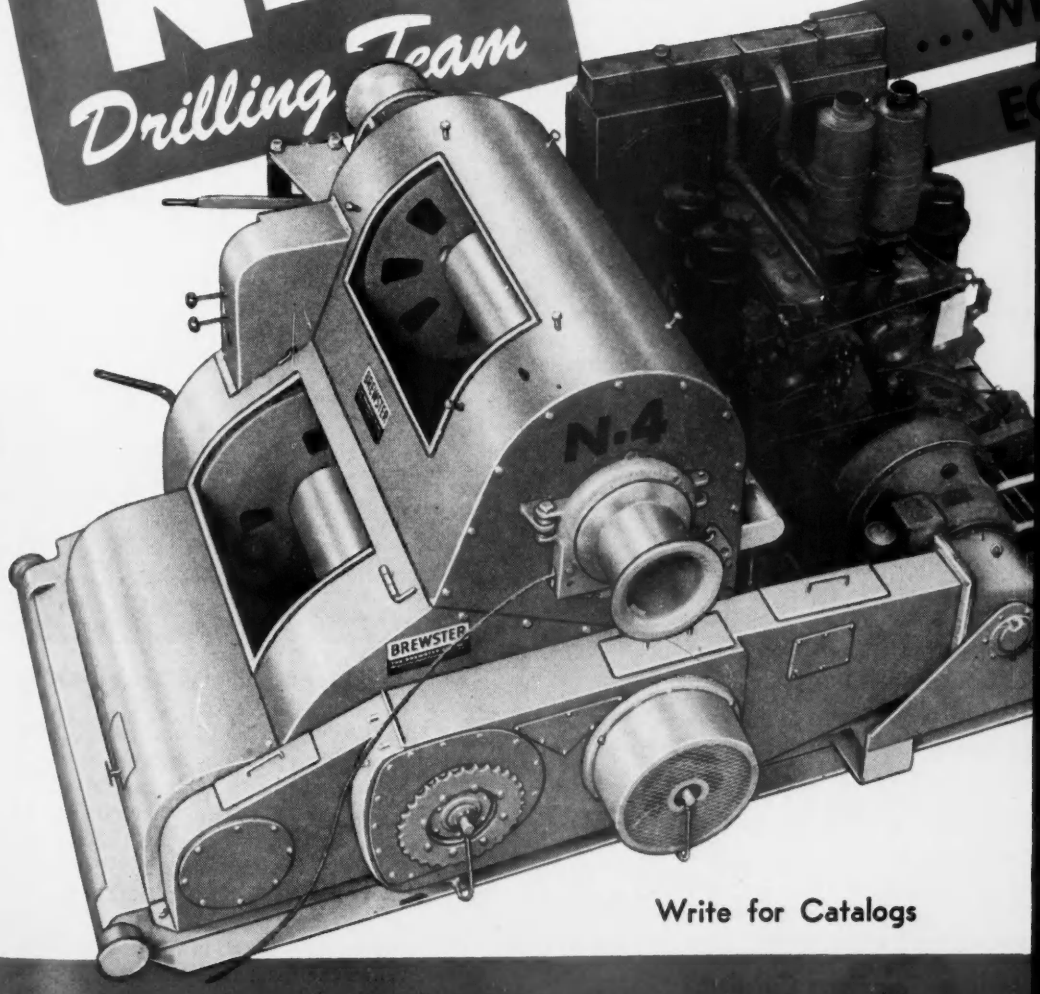

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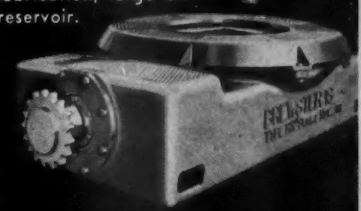

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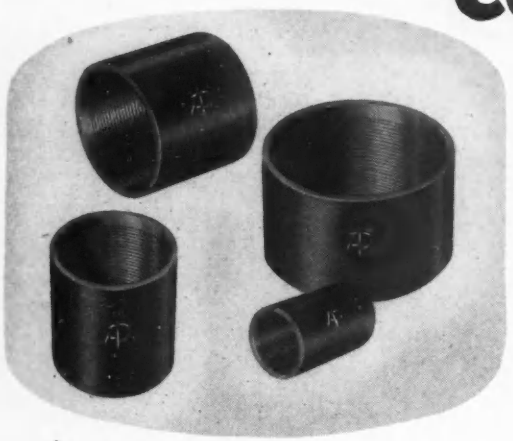

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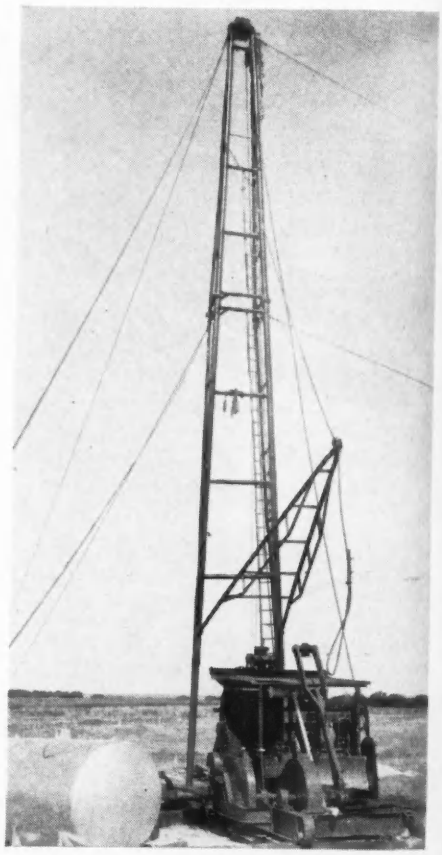
HOW TO—

Use Boomer to Elevate Mast

Where portable masts are used for well servicing and workovers, the top of the mast is usually raised part way up before it is pulled up with the drawworks. An auxiliary boomer may be fastened to the lower end of the mast to give an upward pull. This allows the mast to lie flat on the ground before it is raised.



Fabricated from pieces of 2½-inch and two-inch pipe, the boomer is made light and strong to withstand the high initial load required to start raising the mast. The 2½-inch pipes are 18 feet long with cross bracing of 2-inch every 3 feet. A beam effect is obtained by running two-inch pipe below each of the runners with cross bracing as shown.

When the mast is in the upright position, the boomer hangs out over the engine house and may be used for unloading heavy equipment.

Versatility of this simply-constructed boomer makes it a valuable aid in rigging up portable masts and handling heavy equipment.

Interpretation of Field Data on The Basis of Relative Permeability Ratios

LT. COMDR. F. WARNE GOOCH, JR.
U. S. Navy

By and

MARSH S. WATSON, JR.
Graduate Student, University of Oklahoma

THE AUTHORS APPLY to reservoir performance data theoretical equations developed and demonstrate from their findings that practical petroleum engineering analyses are possible. Plots are worked out which indicate usefulness in evaluating relativity of injected gas, expansion of original reservoir gas, and gravity forces. The authors derive equations and determine practical application values as examples of their application to field work.

WITHIN recent years the proposition of increased oil recovery through injection of gas has been widely treated. Projects applying this principle are relatively sensitive to the limits of profit and loss; therefore, predictions of total gas requirements versus oil recovered are of prime importance to engineers and management. Accurate relationships for describing gas-drive performance, during both primary and secondary phases of production history, are constantly sought so that extrapolations made using field data will be quantitative analyses of future behavior.

A theory of oil displacement by gas has been developed from numerous laboratory experiments involving relative permeability measurements and from gas-drive experiments on cores. The basic work reported by Day and Yuster[1, 2] in which equations for the decline of oil production rate under gas injection were developed was further correlated with the relative permeability-saturation relationship by Muskat's[3] more general derivations. The usefulness of equations resulting from these investigations was further demonstrated and extended by Calhoun.[4]

The relative permeability ratio (k_g/k_o) has been used as a basis for much of this work. This ratio is the relative permeability to gas (k_g/k) divided by the relative permeability to oil (k_o/k) at a specified value of oil saturation. (Relative permeability is defined as the ratio of the amount of fluid flowing at a given saturation to the amount which would flow at 100 percent saturation, conditions of pressure being the same.) Curves describing relative permeability-saturation relationships are usually obtained from laboratory measurements taken on reservoir core samples. Such information may then be used to construct a plot expressing a relationship between the relative permeability ratio and saturation. This ratio lends itself more readily to analysis and to correlations of flow performance than do expressions involving relative permeability only.

In addition to "laboratory" k_g/k_o curves a method has been presented in the literature[4, 10] whereby certain production data can be used, with proper equations, to construct "reservoir" k_g/k_o curves. Being determined from reservoir performance these curves inherently reflect distortions in field behavior caused by artificial controls imposed on the producing mechanism. Nevertheless, this type of information has been found useful in predicting reservoir performance on the basis of past history and also the

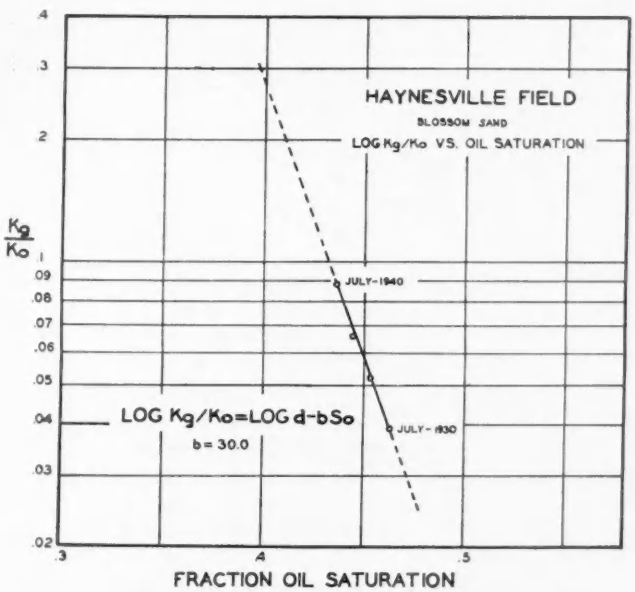


FIGURE 1. Haynesville field data plotted according to Equation 1.

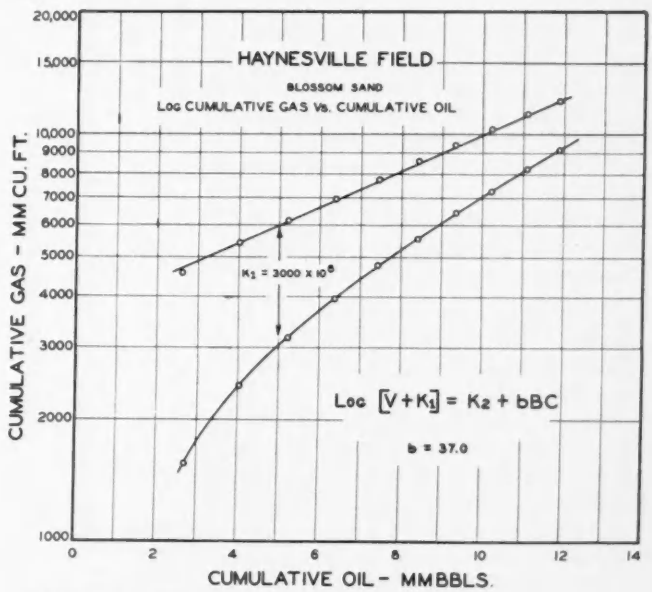

HAYNESVILLE FIELD
BLOSSOM SAND
LOG CUMULATIVE GAS VS. CUMULATIVE OIL
CUMULATIVE GAS - MM CU. FT.
K1 = 3000 x 10^6
Log [V+K1] = K2 + bBC
b = 37.0
CUMULATIVE OIL - MMBBLS.

FIGURE 2. Haynesville field data plotted according to Equation 2.

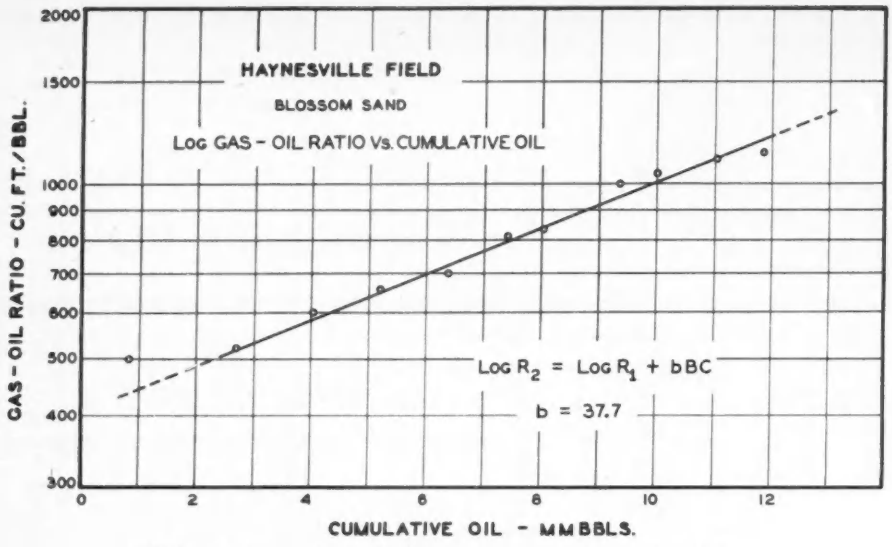


FIGURE 3. Haynesville field data plotted according to Equation 3.

degree of distortion has been utilized as a means for discussing producing efficiency.

The aforementioned method of constructing a k_g/k_o curve from field data and the necessary equations will be shown later. For the purpose of discussion hereinafter curves obtained from laboratory observations will be referred to as "laboratory" k_g/k_o curves and curves constructed from production data will be referred to as "reservoir" k_g/k_o curves.

It has been noted that the relative permeability ratio may vary in magnitude from zero to infinity. However, a simple relationship with oil saturation does exist over a wide range of saturation values. In a porous system containing gas and oil but at high oil saturation the flow of gas is zero, k_g is zero and, therefore, k_g/k_o equals zero. As gas saturation increases, k_g increases but k_o decreases and k_g/k_o increases. When the oil saturation becomes sufficiently low, k_o approaches zero and the value of k_g/k_o approaches infinity. The form of the variation of k_g/k_o vs. S_o is linear over a wide saturation range when plotted on semi-logarithmic coordinates[3]. This relationship has been expressed by the equation $k_g/k_o = ae^{-bS_o}$, where a and b are indigenous reservoir characteristics dependent on the porous media and the fluids involved.

The k_g/k_o curve, as a general rule, develops linearity when the free gas saturation is of the order of 20 percent or greater. It is apparent, therefore, that once sufficient oil has been produced to allow this gas saturation, subsequent reservoir performance should follow the linear k_g/k_o variation. If a reservoir could be produced under the conditions of control imposed on its core sample when studied in the laboratory, it would be a simple matter to apply the trend described to the prediction of reservoir behavior.

Obviously, the ideal case is never realized in field operations; however, the relative permeability ratio has been used as a basis for establishing working engineering relationships for production by gas drive[4].

This paper presents an application of several derived equations to field-performance data from three gas-injection projects.

Basic Equations and General Assumptions

Most operators periodically measure and record the producing gas-oil ratio, the oil production rate, the gas-injection rate, and the reservoir pressure. This information can be used to obtain various plots of performance data, which will express linear relationships between field quantities, provided operating conditions approximate certain limiting assumptions. The following equations are the linear relationships (see appendix for derivation):

$$\text{Ln } k_g/k_o = \text{Ln } a - bS_o \quad (1)$$

$$\text{Ln } (V + K_1) = K_2 + bBC \quad (2)$$

$$\text{Ln } R_2 = \text{Ln } R_1 + bBC \quad (3)$$

$$V = \frac{1}{bB}(R_t - R_{orig}) \quad (4)$$

$$\text{Ln } (Q_o)_2 = \text{Ln } (Q_o)_1 - bBC \quad (5)$$

$$(1/Q_o)_2 - (1/Q_o)_1 = bB(T_2 - T_1) \quad (6)$$

Where:

- V = cumulative gas volume injected, std cu ft
- C = cumulative oil produced, stock tank bbls
- T = time, days
- K = symbol for constants, see appendix
- Q_o = rate of oil flow, bbls tank oil per day
- Q_g = rate of gas flow, std cu ft per day
- R = current gross surface gas-oil ratio, cu ft per bbl
- N = barrels of stocks tank oil originally in the reservoir
- ΔN = cumulative barrels of stock tank oil produced
- k_g/k_o = relative permeability ratio, gas to oil, at S_o
- r = gas in solution, std cu ft per bbl of stock tank oil
- μ = viscosity of reservoir fluid, centipoises
- v = conversion factor, std cu ft of gas to bbls of reservoir gas
- B = formation volume factor for oil
- S = fractional reservoir saturation
- a and b = constants dependent upon the porous media and fluids involved
- Ln = logarithm to base e
- Log = logarithm to base 10

Subscripts 1 and 2 denote times 1 and 2, t denotes any time considered, and orig denotes original conditions. Subscripts o, g, w refer to oil, gas and water, respectively.

In deriving the above equations it was assumed that over the saturation range studied (1) the linear relative permeability ratio variation is valid, (2) reservoir pressure remains constant, (3) gas in solution is negligible as compared to total produced gas-oil ratio, and (4) rate of gas throughput is constant[3]. The above equations are correlations which by virtue of the factors involved in their derivation function according to normal reservoir behavior. Because they are "reservoir equations"[4], changes in surface-controlled conditions which alter the normal trend of operations will be reflected by their plots.

The six equations are of the general form $y = mx + c$, which is the equation of a straight line where m is the slope and c is the y axis intercept. This would mean that field data plotted according to any one of the six relationships should

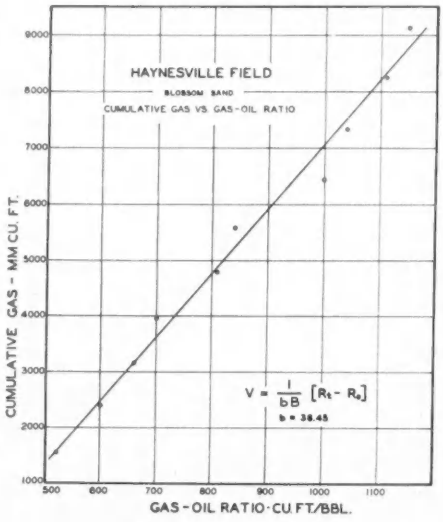


FIGURE 4. Haynesville field data plotted according to Equation 4.

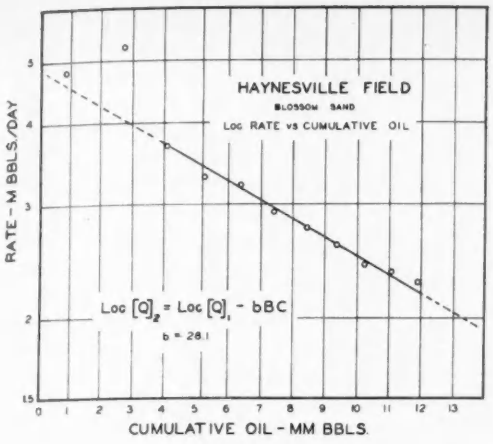


FIGURE 5. Haynesville field data plotted according to Equation 5.

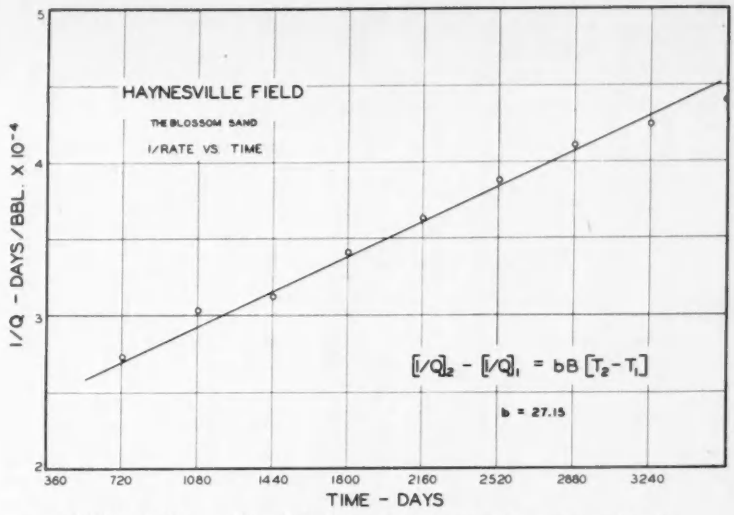


FIGURE 6. Haynesville field data plotted according to Equation 6.

exhibit linearity which, when extrapolated, would serve as a method for estimating future values.

The quantity b is common to all expressions for slope; therefore, if B and pore volume are known, the value of b can be calculated (see Appendix). A comparison of b values by groups for each separate field considered might possibly serve as a means for establishing some index or measure of producing efficiency for a gas-drive project. In some cases an indication of the presence of other active oil-expulsive forces—such as gravity drainage—might be obtained.

Application to Field Performance

Haynesville Field—Blossom Sand. Descriptive field data and reservoir performance charts published in "Secondary Recovery of Oil in the United States" provided material for a gas-drive behavior study of the Haynesville Field—Blossom Sand—located in Louisiana[5]. Pertinent reservoir data for the producing horizon are given in Table 1.

Table 1

Reservoir Data, Haynesville Field—Blossom Sand

Extent of Producing Area	7060 Acres
Average Thickness of Producing Sand	25 ft.
Average Porosity	33.7 pct.
Average Permeability	474 md.
Connate Water	30 pct.
Oil Gravity	35° API
Original Reservoir Temperature	126° F.
Original Reservoir Pressure, Estimated	1100 psi
Pressure During Secondary Recovery	30 to 150 psi
Average Pressure Assumed to be	100 psi
Gas in Solution @ 100 psi	Negligible
Cumulative Production to July 1930	59,548,000 bbls
Cumulative Production to July 1940	70,600,000 bbls
Initial Stock Tank Oil in Place, Estimated	254,000,000 bbls
For Portion of Field History Studied:[6-8]	
μ_o	3.8 cp
B_{orig}	1.27
μ_g	0.011 cp
B_{100}	1.10

Table 2

Tabulated b Values, Haynesville Field—Blossom Sand

Plot	b Value
k_g/k_o vs S_o	30.0
Log V vs C	37.0
Log R vs C	37.7
V vs R	36.5
Log Q_o vs C	28.1
$1/Q_o$ vs Time	27.2

By using the Instantaneous Gas-Oil Ratio Equation in conjunction with an Oil Saturation Equation, a "reservoir" k_g/k_o curve (Figure 1) for ten years of production history was constructed. Field production data measured at given intervals were used in the following equations to obtain values of k_g/k_o and S_o.

(See Appendix for limiting assumptions and example calculations).

$$\frac{k_g}{k_o} = (R - r)\ \frac{\mu_g}{\mu_o}\ \frac{V}{B} \qquad (7)$$

$$S_o = (1 - S_w)\left(1 - \frac{\Delta N}{N}\right)\frac{B_t}{B_{orig}} \qquad (8)$$

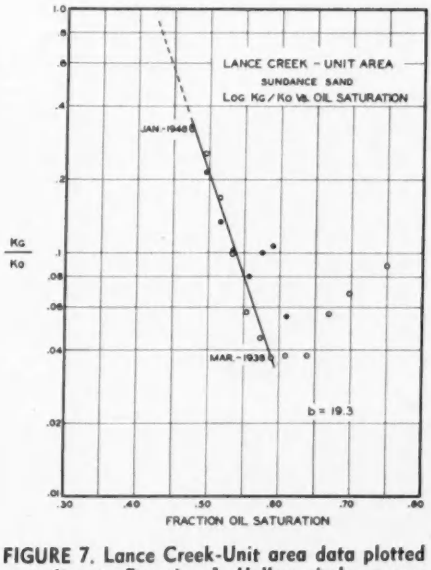


FIGURE 7. Lance Creek-Unit area data plotted according to Equation 1. Hollow circles represent values obtained using (R — r); solid circles represent values obtained using the injection gas-oil ratio.

Sufficient information was available on the Haynesville Field to plot the six correlations discussed. The point of zero cumulative oil on all plots corresponds to an actual cumulative production of 59,548,000 barrels. The pore volume was calculated and b values obtained for each case (Table 2). All of the curves exhibited good linearity which should permit accurate extrapolation. The b values for all plots containing a gas term (Figures 2, 3 and 4) are approximately equal but exceed in amount those measured for the two plots involving daily oil production rate (Figures 5 and 6) and also the "reservoir" k_g/k_o curve b value (Figure 1).

These differences may indicate the presence of some degree of gas by-passing, since more efficient production with no by-passing would tend to decrease the slope of the three plots directly affected by gas values. Actually the "reservoir" k_g/k_o curve b value should agree with the gas plots since the k_g/k_o quantity is calculated from the producing gas-oil ratio. In this particular case it is believed that the disagreement is due primarily to uncertainties in some of the original reservoir data, i.e., correlation curves were used in approximating values of B, μ_o and μ_g at estimated reservoir pressures since PVT data were not available.

The Haynesville Field results serve as an excellent example of the theoretical relationships applied to a low-pressure, gas drive, secondary recovery project. All plots illustrate the procedure which can be used in "testing" field data for linearity.

Lance Creek-Unit Area—Sundance Sand. Reservoir performance data recently published on the Lance Creek-Unit Area, Sundance Sand[9], a pressure-maintenance project located in Wyoming, were studied using the same correlations previously described. Results of the analysis are shown by Figures 7

the analysis are shown by Figures 7 through 12. The point of zero cumulative oil on all plots corresponds to an actual cumulative production of 8 million barrels. Reservoir data for the Sundance Sand are given in Table 3.

Table 3

Reservoir Data, Lance Creek-Unit Area—Sundance Sand

Extent of Producing Area	1450 Acres
Average Thickness of Producing Sand	53 ft.
Average Porosity	25 pct.
Average Permeability	260 md.
Connate Water	25 pct.
Gravity of Oil	47.5° API
Original Reservoir Temperature	155° F.
Original Reservoir Pressure, Estimated	1550 psi
Average Pressure During Period Studied	800 psi
Gas in Solution @ 800 psi	535 cu ft/bbl
Initial Stock Tank Oil in Place	73,000,000 bbls
Cumulative Production to March 1938	10,000,000 bbls
Cumulative Production to January 1946	22,000,000 bbls
For Portion of Field History Studied:	
μ_o	0.425 cp
B_{orig}	1.52 (Est.)
μ_g	0.014 cp (Est.)
B_{800}	1.39

Table 4

Tabulated b Values, Lance Creek-Unit Area—Sundance Sand

Plot	b Value
k_g/k_o vs S_o	19.3
Log V (Produced Gas) vs C	18.8
Log Injection Ratio vs C	17.8
V vs Injection Ratio	19.4
Log Q_o vs C	9.4
$1/Q_o$ vs Time	9.1

The writers of the Lance Creek paper discuss the possibility of a small initial gas cap or stray free-gas zone at the top of the producing structure. Early development wells were structurally high and produced with high gas-oil ratios causing a high pool ratio. As the structurally lower wells were drilled, the producing ratio decreased; and, as a result, oil was produced more efficiently. This decline and the effect of close operating control of the gas-oil ratio during the initial phase of pressure maintenance operations are shown by the "reservoir" k_g/k_o curve (Figure 7). After approximately one year of gas injection the curve exhibits a trend which approaches linearity. Although a straight line can be drawn through the trend, attention is called to a peculiar "S" shaped curve suggested by the plotted values. This variation is also present in the remaining two plots (Figures 9 and 10) dependent on the gas-oil ratio and is accented by the larger scales used. In this instance the solution ratio was not considered negligible as compared to the total gas-oil ratio. For this reason, plus consideration of the possibility that its inclusion might exert a straightening influence on the gas-oil ratio curves, (R — r) was plotted versus cumulative oil and gas. Although the curves obtained by acknowledging the solution ratio were slightly more desirable than the plots ignoring it, there was little real difference between the two.

The results obtained by plotting the current gross gas-oil ratio minus the solution gas-oil ratio (from PVT data) are represented by the solid-line curves in Figures 9 and 10. These two curves do not satisfactorily support a linear trend and their extrapolation would be a questionable matter. It was then decided to plot the gross gas-oil ratio minus the net gas-oil ratio, which is the *injection* gas-oil ratio, as another test for linearity. The dashed line in Figure 9 shows a plot of *injection* gas-oil ratio

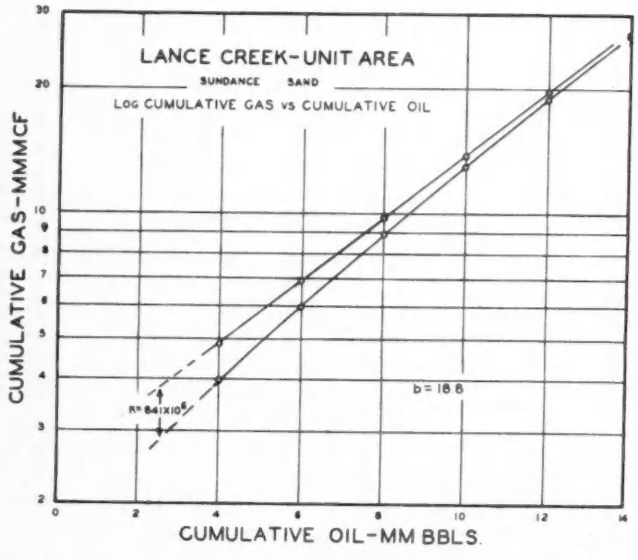
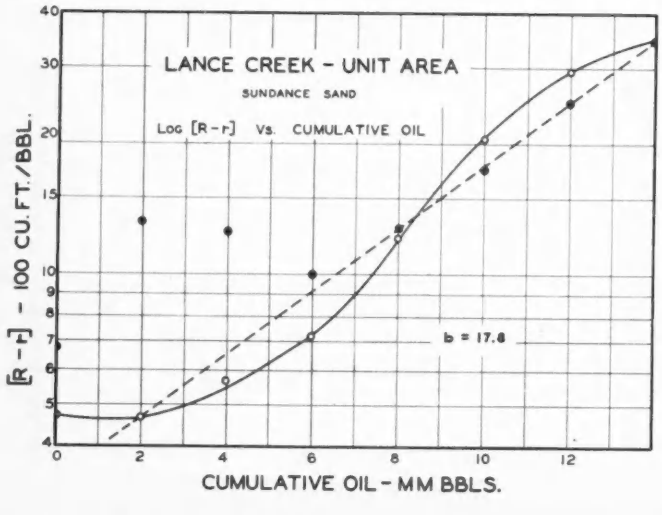
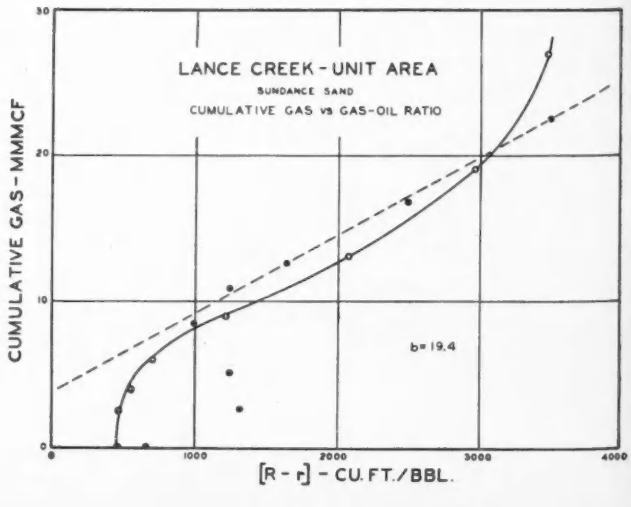


FIGURE 8 *(left)*. **Lance Creek-Unit area data plotted according to Equation 2 using cumulative gas produced.**

FIGURE 9 *(below left)*. **Lance Creek-Unit area data plotted according to Equation 3. Solid line is based on (R — r) values and dashed line is based on injection gas-oil ratio values.**

FIGURE 10 *(below right)*. **Lance Creek-Unit area data plotted according to Equation 4. Solid line is based on (R — r) vs. cumulative gas produced and dashed line is based on the injection gas-oil ratio vs. cumulative gas injected.**





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versus cumulative oil. The solid line in Figure 10 shows a plot of $(R - r)$ versus cumulative gas produced, and the dashed line shows a plot of *injection* gas-oil ratio versus cumulative gas injected.

The irregular pattern at the beginning of each plot based on injected gas is followed by a definite linear trend representing six years of field history. Two main factors are responsible for the erratic portions of these curves: (1) the first value plotted in each case represents conditions six months following the inception of gas-injection and the point where reservoir pressure first indicated stabilization at 800 psi, (2) the following two values, both high, were measured at times when injected gas exceeded produced gas (thus the *injection* gas-oil ratio exceeded the gross gas-oil ratio) causing the reservoir pressure to increase. As a matter of interest the "reservoir" k_g/k_o curve was recalculated substituting the *injection* gas-oil ratio in place of $(R - r)$. The k_g/k_o values so obtained are shown on Figure 7 by the solid circles.

Good linearity was obtained by plotting cumulative gas produced versus cumulative oil produced (Figure 8); also, both graphs using oil production rate (Figures 11 and 12) exhibit a definite trend.

A grouping of b values (Table 4) indicates that all plots involving gas directly are again high as compared to those concerning daily oil rates. It is pertinent to note that the b values for the "reservoir" k_g/k_o and gas curves agree reasonably with a "laboratory" k_g/k_o curve b value of 19.5 calculated from consolidated sand data as reported by Botset.[12]

According to equations 3 and 5 the slopes obtained from Figures 9 and 11 should be equal in amount and opposite in sign. The low b value of about 9 for the oil curves compared to an average of 18.8 for the gas curves poses a debatable point of interpretation. It is beyond the scope of this paper and the limited data treated to propose or develop specific "cause and effect" rules of field behavior; however, some general observations will be offered.

Gravity drainage is considered to be effective as an active oil-producing force in the Lance Creek Sundance reservoir.[9] This factor would tend to lower the field gas-oil ratio and thus indicate greater over-all efficiency. For example, if by-passing were present, its true reflection by performance data would be distorted by the oil production contributed by gravity forces. It appears that the effect on all six curves would be in the direction of lowering the b values. The extent to which evidence of by-passing will be counterbalanced by the presence of gravity drainage is not readily apparent.

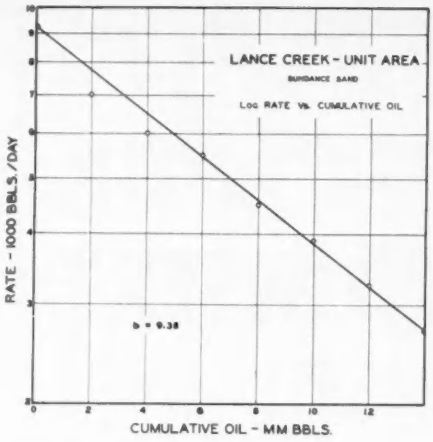

FIGURE 11. Lance Creek-Unit area data plotted according to Equation 5.

Although a direct comparison is not intended, it is observed that a "reservoir" k_g/k_o curve reported[10] for a "largely unconsolidated" sand reservoir producing mainly by gravity drainage has a b value of about 5.

Presumably, the existence of consolidated sand and gas injection would both contribute toward a higher b value if the two were incorporated in a reservoir utilizing gravity drainage. Based on this consideration, the average b value of 9.3 from the Sundance Sand oil rate curves agrees rather well with the unconsolidated sand, no gas injection example. This fair, perhaps fortuitous, agreement suggests that plots of the production rate versus cumulative oil produced and time might prove quite useful as an indicator of gravity drainage in other similar studies of field data.

It is implicitly assumed in this method of analysis that the decline and trend of oil production is governed solely by the ability of the reservoir to transmit its fluids. In consequence of proration, performance data from many fields would not respond to the correlations. The effect of a constant daily oil rate over a long period of time can be immediately appreciated if Figures 11 and 12 are reviewed with an imaginary horizontal line replacing some portion of the real curve. A certain amount of production control was exercised on the Lance Creek-Unit Area as evidenced by the step-like decline of the oil production curves. However, for the most part, the behavior recorded is an acceptable approximation of the "true" decline information desired. This supposition appears to be justified by the linearity exhibited in Figures 11 and 12. In all probability, a reservoir whose potentialities appreciably exceeded its prorated allowable could not be so regulated that a compulsory oil rate decline would support a consistent b value over several years of production history.

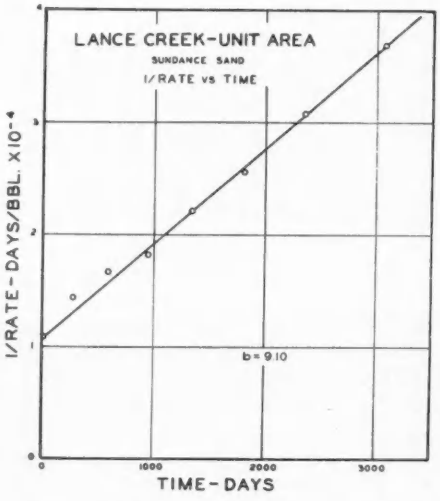

FIGURE 12. Lance Creek-Unit area data plotted according to Equation 6.

Langlie Unitized Repressuring Project. As previously mentioned, all equations developed to give the correlations based on the k_g/k_o concept are reservoir equations.[4] A change of operating conditions which imposes new and different producing conditions on the reservoir will be reflected by a departure from linearity in the correlation sought. Variations in behavior may be caused by shutting in high ratio wells, altering injection volumes, changing rates, remedial workovers or re-completions. Such changes, if severe, result in a redistribution of reservoir flow lines and either an increase or a decrease in efficiency. Some of these effects are demonstrated by performance of the Langlie Unit, which is a repressuring project located in New Mexico.[11] Reservoir data available in the reference consulted are given in Table 5.

Table 5

Reservoir Data, Langlie Unitized Repressuring Project

Extent of Producing Area	Not available
Average Net Feet of Producing Sand	10-15 ft.
Average Porosity	10 pct.
Average Permeability	8 md
Connate Water	Not available
Gravity of Oil	34° API
Original Reservoir Temperature	Not available
Original Reservoir Pressure, Estimated	1400 psi
Average Pressure During Period Studied, Estimated	590 psi
Gas in Solution @ 550 psi	264 cu ft/bbl
Initial Stock Tank Oil in Place	Not available
Cumulative Production to October 1942	190,000 bbls
Cumulative Production to October 1944	350,000 bbls

Numerical values for b were not figured, because necessary data for calculating the pore volume were not available. Langlie performance data show poor parallelism between injected and produced gas volumes during various

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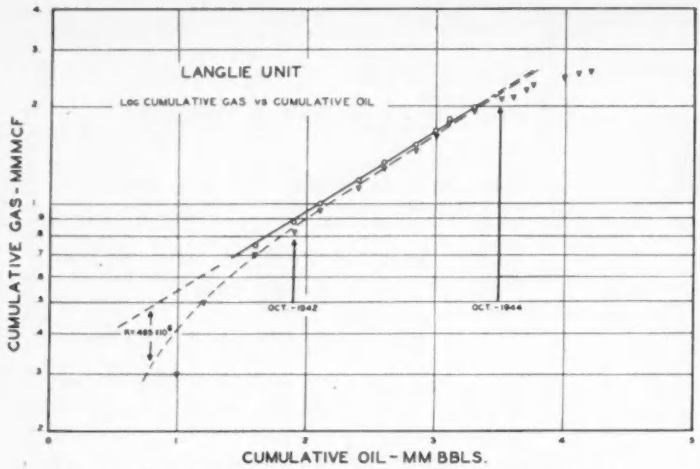

FIGURE 13. Langlie Unit data plotted according to Equation 2.

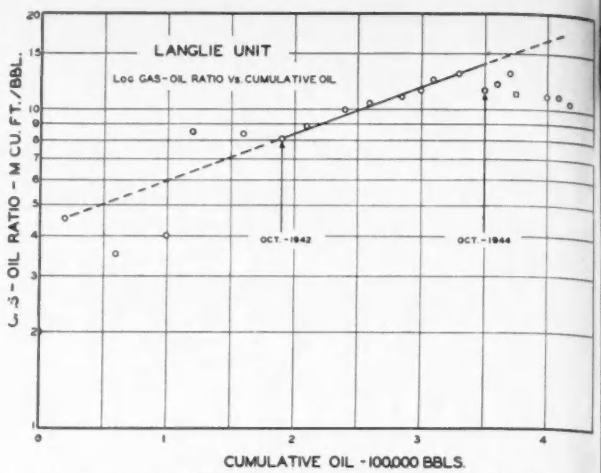

FIGURE 14. Langlie Unit data plotted according to Equation 3.

portions of field history. Insistence on a strict interpretation of the limiting assumptions of the equations would disqualify use of these data. Before an uncalculating view of project performance is taken, the "linearity tests" should be tried by plotting counterpart values against both cumulative injected and produced gas volumes if reservoir pressure is reasonably constant. All illustrations for this study were based on injected volumes, and linearity is shown during a two-year period.

In Figures 13 through 17 data are plotted from the beginning of gas injection through a point where injection was temporarily ceased. The random pattern preceding the two-year linear period depicts unsettled producing conditions caused by the following consecutive, surface-controlled events: (1) gas injection started in the second injection well, (2) shooting of the second injection well, (3) shutting in of the second injection well for 30 days, and (4) packer reset in the second injection well. Following this final mechanical adjustment the drive proceeded without further changes for approximately two years. The break after the linear period is due to a producing well being shut in and, shortly thereafter, gas injection being stopped for approximately two months while compressors were under repair. Resumption of injection operations was followed by shooting of a lower zone and resetting of the second injection well packer for more selective injection into this lower zone. Over-all conditions are then defined by a lower reservoir pressure, which stabilized at about 475 psi, and a smaller volume of gas being injected. It should be noted that an entirely separate reservoir was not being treated by these changes for all principal sands which originally received gas were still being repressured by one or the other, and in some cases both, of the two injection wells. However, all changes are tantamount to "new and different" producing conditions.

The type of departure mentioned is least apparent in Figure 13, although endpoints show slight deviation. Figure 15 exhibits a shift to a short period of linearity following the main two-year trend; however, values then present an irregular pattern.

Following the break in the normal production decline plotted in Figure 16, a different linear inclination with a steeper slope is developed for the second phase of repressuring operations. Provided no further changes are made in external conditions, this trend should continue. The same general explanation holds for Figure 17 involving daily production rate and time. The point plotted in the break shown represents the lowest rate to which production dropped during no gas injection. The new trend indicated is well supported by the oil production data. This suggests the possibility that curves based on oil rates are less sensitive to temporary manipulations of the gas volume injected. It appears that if previous practice is at least approximated by subsequent operations the oil production curves will indicate an adjustment to the new drive more rapidly than will gas curves.

Summary

1. Several theoretical equations developed in the literature have been applied to the performance data of three volumetric-type reservoirs operated as gas-injection projects.

2. Despite the fact that operating conditions do not rigidly adhere to the limiting assumptions explicit in the derivation of the equations, practical petroleum engineering analyses are possible.

3. The problem of gas by-passing and its effect on the slope of the "reservoir" k_g/k_o curve has been appreciated in the literature; however, discussion is still limited to an envelope of curves showing values of the right order of magnitude rather than curves for specific degrees of gas by-passing.

4. There is a possibility that these plots might be useful in evaluating the relative activity of injected gas, expansion of original reservoir gas, and gravity forces as oil producing agents in a specific reservoir to be studied. Additional investigation of other fields utilizing gravity drainage would provide valuable data for establishing the natural range of b values.

5. Data resulting from fields subject to proration is of little use, for the purpose discussed herein, until such time as the rate of oil production is dependent on reservoir conditions and not on surface facilities.

6. Mechanical changes in operating control will be reflected by discontinuities in the plotted relationships.

ACKNOWLEDGMENT

The writers express their appreciation to Dr. John C. Calhoun, Jr., chairman, School of Petroleum Engineering, University of Oklahoma, whose classroom discussions prompted this paper and whose suggestions have been freely used in its preparation.

REFERENCES

[1] Predictions of Behavior in Air-Gas Drive, Day and Yuster, Bulletin No. 41, The Pennsylvania State College, Mineral Industries Experiment Station.

[2] Gas Requirements in Gas Drive Recovery, Yuster and Day, The Producers Monthly, Oct. 1946, Vol. 10, No. 12.

[3] A Note on Gas Repressuring, M. Muskat, Producers Monthly, Feb. 1946, Vol. 10, No. 4.

[4] Engineering Fundamentals, J. C. Calhoun, Jr., Nos. 322, 337, 340, 341 from Advanced Reservoir Engineering reprinted by The Oil and Gas Journal. Nos. 356, Dec. 23, 1948; 357, Dec. 30, 1948; 358, Jan. 6, 1949; 359, Jan. 13, 1949; 360, Jan. 20, 1949, The Oil and Gas Journal.

[5] Secondary Recovery in Louisiana, A. L. Vitter, Jr., Secondary Recovery of Oil in the United States, API publication.

[6] The Viscosity of Air, Water, Natural Gas, Crude Oil, and Its Associated Gases at Oil Field Temperatures and Pressures, Beal, Trans. AIME (1946), Vol. 165.

[7] Viscosity of Natural Gases, Bicher and Katz, Trans. AIME (1944), Vol. 155.

[8] Effect of Crude Gravity on the Performance of Gas Drive Reservoirs, Muskat and Taylor, The Petroleum Engineer, December, 1946.

[9] Lance Creek Sundance Reservoir Performance—A Unitized Pressure-Maintenance Project, Elkins, French and Glenn, Petroleum Technology, July, 1948.

[10] The Importance of Injected Gas as a

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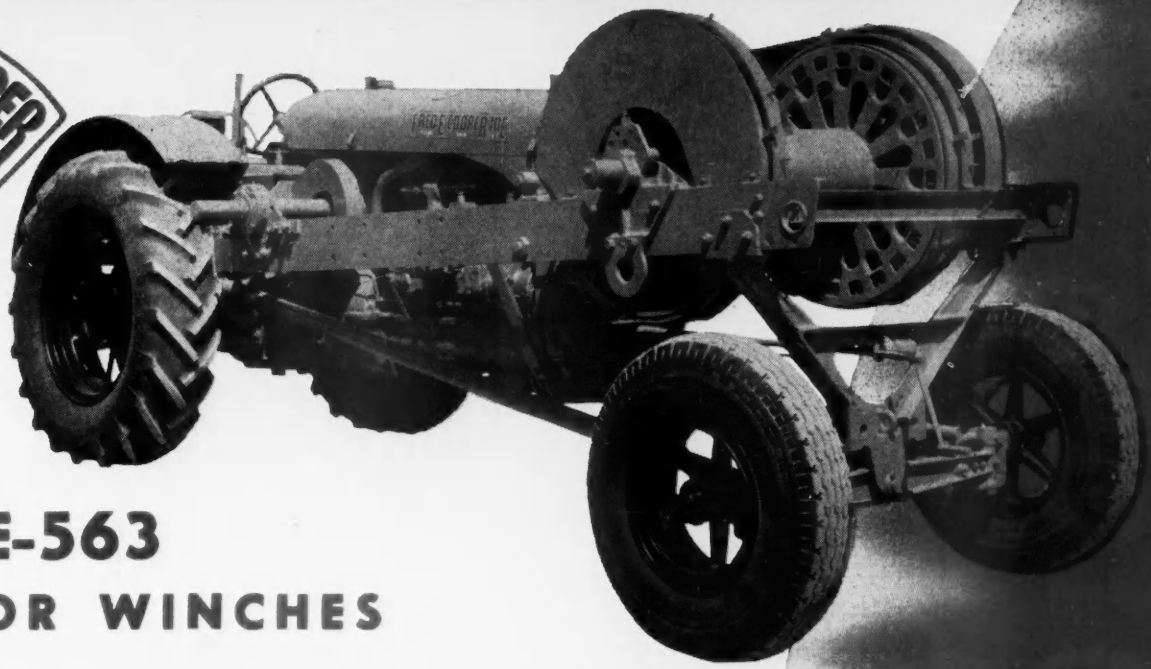

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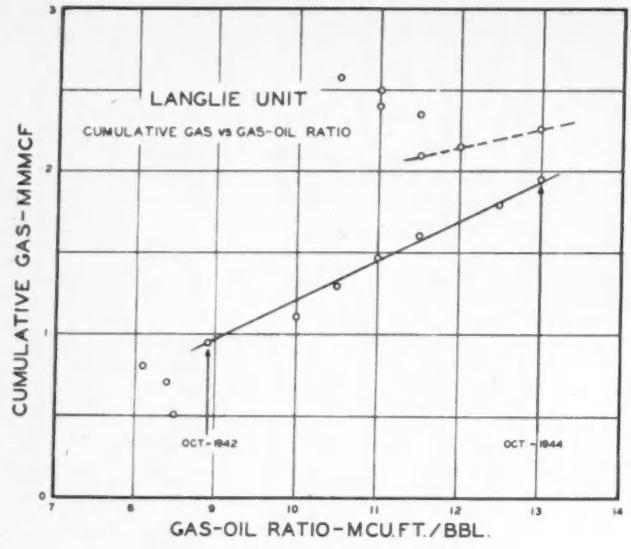
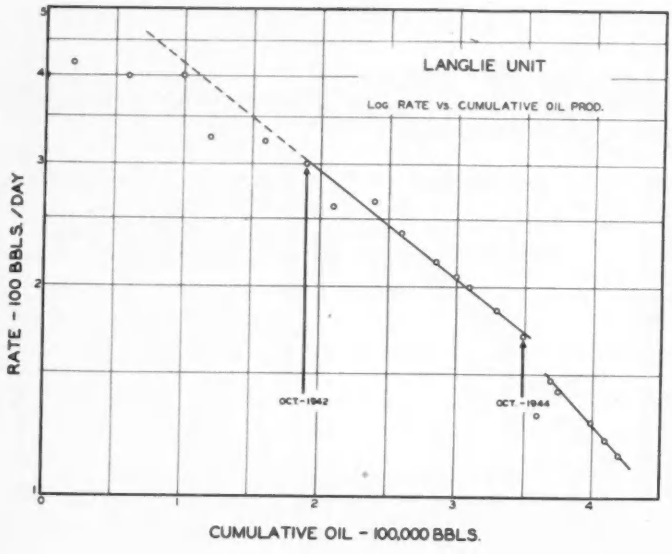
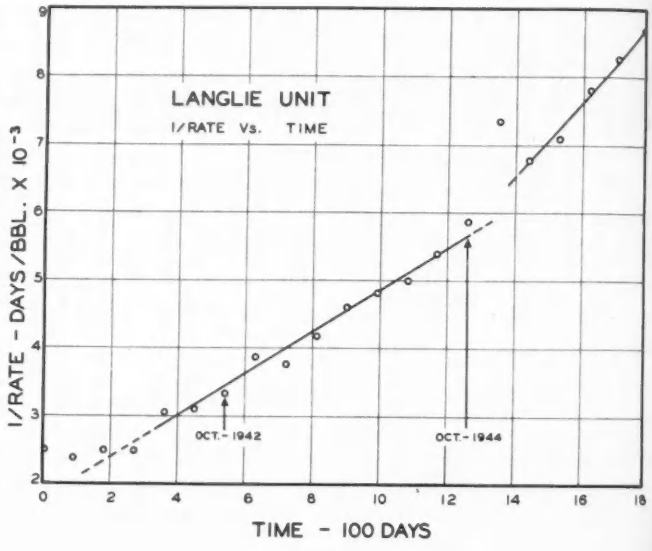


FIGURE 15 *(left)*. Langlie unit data plotted according to Equation 4.

FIGURE 16 *(below left)*. Langlie unit data plotted according to Equation 5.

FIGURE 17 *(below right)*. Langlie unit data plotted according to Equation 6.





Driving Medium in Limestone Reservoirs as Indicated by Recent Gas-Injection Experiments and Reservoir-Performance History, L. E. Elkins, Supplement 2 to Secondary Recovery of Oil in the United States—1942, API publication.

[11] Five Years of Operation at the Langlie Unitized Repressuring Project, R. L. Gray, The Oil Weekly, November 25, 1946.

[E] Flow of Gas-Liquid Mixtures through Consolidated Sand, H. G. Botset, AIME (1940), Vol. 136.

APPENDIX

Derivation of Equations. The derivations of the equations used in this paper have been compiled from literature[1-4] and are included for ready reference. The equations used in the text are underlined heavily. The basic assumptions made are primarily those limiting the analysis to gas-driven reservoirs. These are (1) that the amount of reservoir pore volume remains constant during the production history, and (2) that the oil and the gas which remains within the reservoir be distributed evenly throughout the pore space.

Let S_o/B equal stock tank oil per unit pore volume; then the cumulative oil produced per unit of pore volume between times t_1 and t_2 will be:

$$C = (S_o/B)_1 - (S_o/B)_2 \qquad (1)$$

As previously shown over a large range of saturation values, the relative permeability ratio can be expressed analytically as:

$$k_g/k_o = ae^{-bS_o}$$

or

$$\underline{S_o = \frac{\text{Ln } a - \text{Ln } k_g/k_o}{b}} \qquad (2)$$

From the instantaneous gas-oil ratio equation which is limited by the assumptions that (1) the pressure drawdown is zero, (2) the gas and oil are uniformly distributed and are flowing according to the equilibrium relative permeability concept, and (3) the pressure gradients in the gas are the same as those in the oil phase:

$$\frac{k_g}{k_o} = (R - r)\frac{\mu_g}{\mu_o}\frac{v}{B} \qquad (3)$$

Substituting for k_g/k_o in Eq 2 yields the following equation:

$$\underline{S_o = \frac{\text{Ln } a - \text{Ln}\left[(R - r)\frac{\mu_g}{\mu_o}\frac{v}{B}\right]}{b}} \qquad (4)$$

Substituting this in Eq 1 gives the following equation for cumulative oil:

$$C = \underline{\frac{\left[\text{Ln } a - \text{Ln}(R - r)\frac{\mu_g}{\mu_o}\frac{v}{B}\right]_1}{bB_1}} - \underline{\frac{\left[\text{Ln } a - \text{Ln}(R - r)\frac{\mu_g}{\mu_o}\frac{v}{B}\right]_2}{bB_2}} \qquad (5)$$

Eq 5 is subject only to limitations applying to Eqs 2 and 3. However, if it is assumed in secondary recovery that r is negligible compared to R and that reservoir pressure remains constant, then B_1 equals B_2, $\left(\frac{\mu_g}{\mu_o}\right)_1$ equals $\left(\frac{\mu_g}{\mu_o}\right)_2$, v_1 equals v_2 and Eq 4 becomes:

$$C = \frac{1}{b\,B}(\text{Ln } R_2 - \text{Ln } R_1)$$

or

$$\underline{\text{Ln } R_2 = \text{Ln } R_1 + bBC} \qquad (6)$$

If Q is defined as rate per unit of pore volume, then $R = Q_{gas}/Q_{oil}$ and substituting this in Eq 6 gives:

$$\text{Ln}(Q_g)_2 - \text{Ln}(Q_o)_2 = \text{Ln}(Q_g)_1 - \text{Ln}(Q_o)_1 + bBC \qquad (7)$$

Furthermore, if it is assumed that rate of gas flow is constant per unit of time as is the case in many gas injection, secondary recovery projects, Eq 7 becomes:

$$\underline{\text{Ln}(Q_o)_2 = \text{Ln}(Q_o)_1 - bBC} \qquad (8)$$

The total gas produced or injected during the time interval from o to t is written as:

$$V = \int_o^t Q_g dt \qquad (9)$$

the rate of gas production or injection can be written from Eq 3 as follows:

$$Q_g = Q_o\left(\frac{k_g}{k_o}\frac{\mu_o}{\mu_g}\frac{B}{v} + r\right) \qquad (10)$$

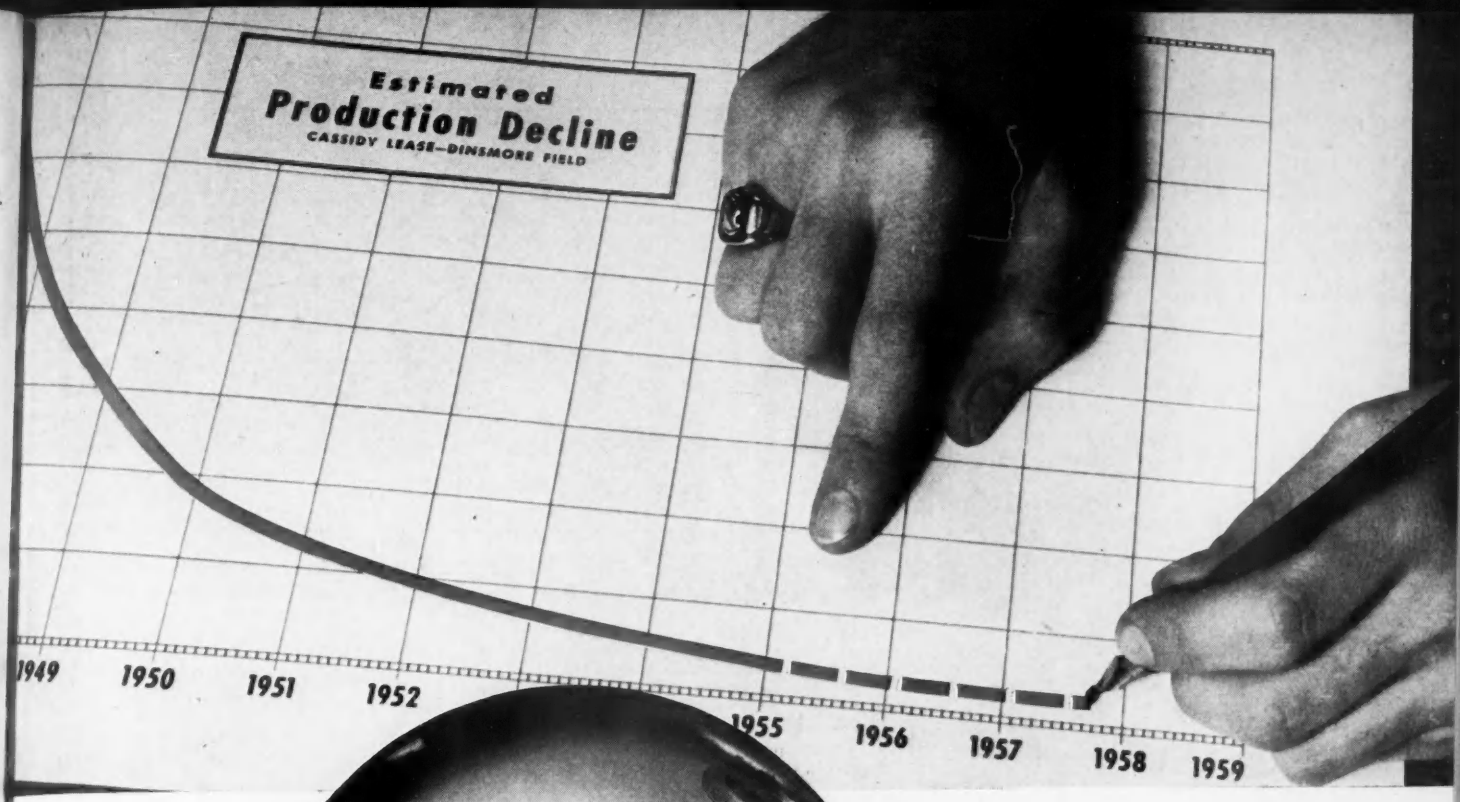
Therefore, substituting 10 in 9, and including the previously considered simplifying assumptions, gives:

$$V = \frac{\mu_o}{\mu_g}\frac{B}{v}\int_o^t Q_o\frac{k_g}{k_o}dt \qquad (11)$$

Substituting Eq 2 and $Q_o = \frac{d\,S_o\,B}{dt}$ which is a definition of oil rate, then integrating gives:

$$V = \frac{\mu_o}{\mu_g}\frac{a}{vb}\left[(e^{-bS_o})_t - (e^{-bS_o})_o\right] \qquad (12)$$

Rearranging and taking the logarithm of both sides yields the following equation:



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However, if pressure is constant, Eq 1 becomes:

$$(S_o)_2 = \left[\left(\frac{S_o}{B}\right)_t - C\right]B$$

Substituting this in Eq 13 gives:

$$\text{Ln}\left[V + \frac{\mu_o}{\mu_g}\frac{a}{vb}(e^{-bS_o})_o\right] = \text{Ln}\left[\frac{\mu_o}{\mu_g}\frac{a}{bv} - b(S_o)_t\right] + bBC \qquad (14)$$

or

$$\text{Ln } V + K_1 = K_2 + bBC$$

Where $K_1 = \frac{\mu_o}{\mu_g}\frac{a}{vb}(e^{-bS_o})_o$ and

$$K_2 = \text{Ln}\left[\frac{\mu_o}{\mu_g}\frac{a}{vb} - b(S_o)_t\right]$$

Using Eqs 2 and 12 the following relation is obtained:

$$V = \frac{\mu_o}{\mu_g}\frac{a}{vb}\left[\left(\frac{k_g}{k_o}\right)_t - \left(\frac{k_g}{k_o}\right)_o\right] \qquad (15)$$

then resubstituting the gas-oil ratio Eq 3 into Eq 15 it becomes:

$$V = \frac{1}{bB}(R_t - R_o) \qquad (16)$$

or

$$R_t = R_o + bBV$$

Since $C = \int_{t_1}^{t_2} Q_o\,dt$ and in the differential form can be written as follows:

$$dC = Q_o dt \qquad (17)$$

then placing Eq 8 in differential form and substituting Eq 17 in 8 gives:

$$\frac{-1}{bB}\frac{dQ_o}{Q_o} = Q_o dt \qquad (18)$$

which when integrated between the limits t_1 and t_2 gives:

$$\left(\frac{1}{Q_o}\right)_2 - \left(\frac{1}{Q_o}\right)_1 = bB\,(t_2 - t_1)$$

Sample Calculations. To calculate a b value from the plot of Log Q_o vs C for the Haynesville Field (Fig. 5), two points are selected on the plotted line. Consider them to be Point 1 (log 2200, 11.8 × 10^6) and Point 2 (log 4100, 2.5 × 10^6). From the equation of this line the slope is $\frac{-bB}{2.303 \times pv}$ where pv is the pore volume in bbls (461 × 10^6 bbls) and B is the formation volume factor (1.1) at the time considered.

Since all the equations were derived using natural logarithms and the plots were made on common semi-logarithmic paper, the conversion factor 2.303 must be used.

Substituting the above values in the equation

$$\text{Slope} = \frac{-bB}{2.303 \times pv}:$$

$$-\frac{b\,1.1}{2.303 \times 461 \times 10^6} = \frac{\log 2200 - \log 4100}{(11.8 - 2.5) \times 10^6}$$

Solving for b:

$$b = -28.1$$

The same method is used in calculating slopes for the other five plots. A tabulation of all equations and their slope equivalents follows:

Plot	Slope Equivalent
log V vs C	$\frac{bB}{2.303 \times pv}$
log R vs C	$\frac{bB}{2.303 \times pv}$
log Q_o vs C	$\frac{-bB}{2.303 \times pv}$
V vs R	$\frac{pv}{bB}$
$1/Q_o$ vs t	$\frac{bB}{pv}$
k_g/k_o vs S_o	$\frac{-b}{2.303}$

To calculate the constant K_1 to be added to V in the plot of Log V vs C for the Haynesville Field (Figure 2), first plot V vs C on coordinate paper as in Figure 18. This should give a smooth curve from which two points C_1 and C_2 are chosen with values (2400 × 10^6, 4 × 10^6) and (9000 × 10^6, 11.8 × 10^6). Then solve for the arithmetic mean (C_3):

$$C_3 = \frac{C_1 + C_2}{2} = \frac{(4 + 11.8) \times 10^6}{2} = 7.9 \times 10^6$$

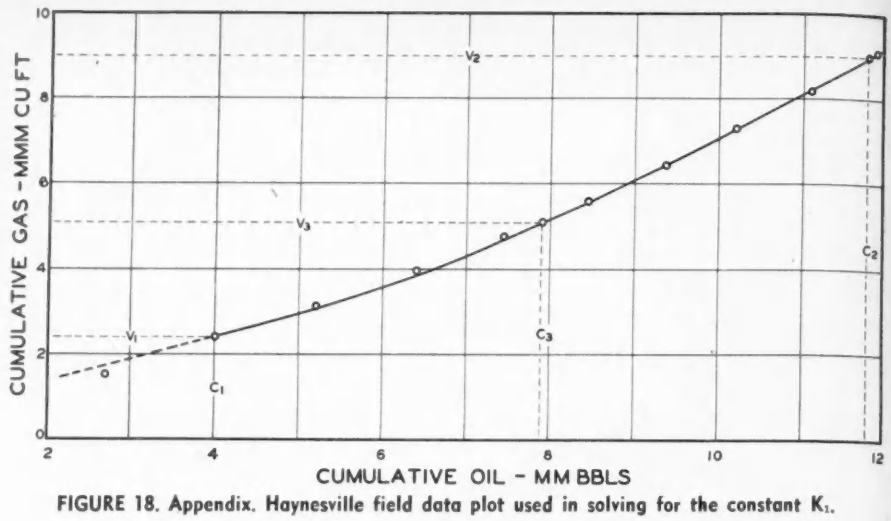


FIGURE 18. Appendix. Haynesville field data plot used in solving for the constant K_1.

Read the corresponding value of (V_3) from the coordinate plot:

$$V_3 = 5050 \times 10^6$$

The final equation to be solved is:

$$K_1 = \frac{V_1V_2 - V_3^2}{V_1 + V_2 - 2V_3}$$

Substituting the above values in the equation:

$$K_1 = \frac{2400 \times 9000 \times 10^{12} - (5050 \times 10^6)^2}{[2400 + 9000 - (2 \times 5050)] \times 10^6}$$

$$K_1 = 3000 \times 10^6$$

To construct a "reservoir" k_g/k_o vs Saturation curve the following data for July, 1940, are obtained from Table 1 and production curves:

$\Delta N = 70{,}600{,}000$ bbls
$N = 254{,}000{,}000$ bbls
$S_w = .30$
$B = 1.1$
$B_{orig} = 1.27$
$R = 1125$ cu ft/bbl
$r =$ negligible
$\mu_o = 3.8$ cp
$\mu_g = 0.011$ cp

$$v = \frac{14.7}{520 \times 5.62} \times \frac{\text{Form. Temp.}}{\text{Form. Pres.}} \times \text{gas comp. factor} = .01 \text{ bbls/cu ft}$$

The above information and the following equations are used to solve for one point on the k_g/k_o vs Saturation curve:

$$\frac{k_g}{k_o} = (R - r)\frac{\mu_g}{\mu_o}\frac{v}{B}$$

$$S_o = \left(1 - \frac{\Delta N}{N}\right)(1 - S_w)\left(\frac{B}{B_{orig}}\right)$$

Substituting the above values in these equations:

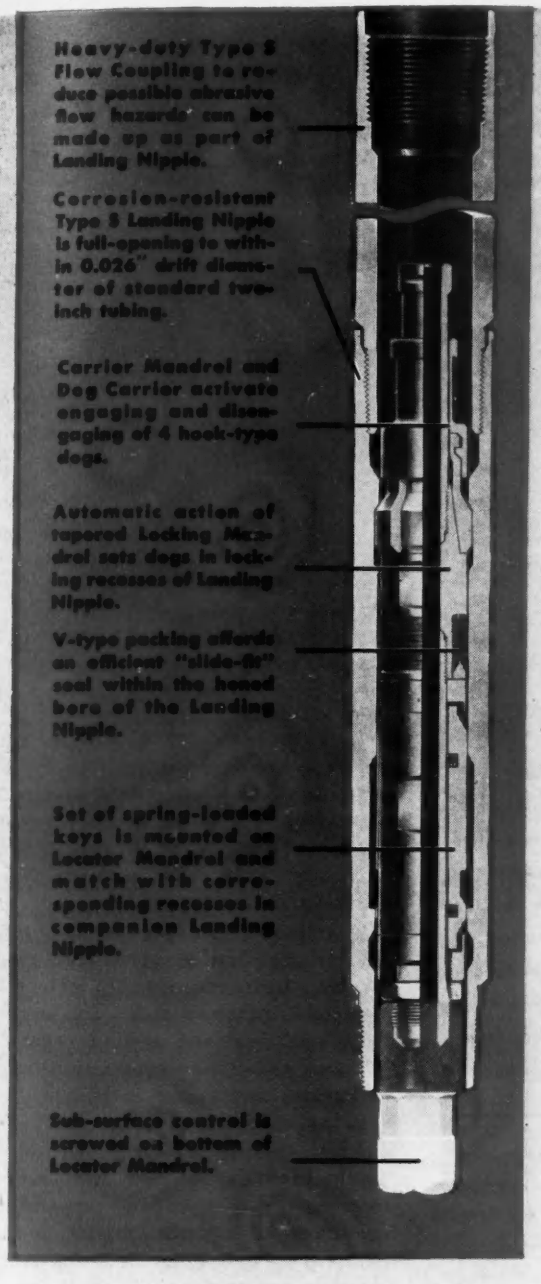
$$\frac{k_g}{k_o} = 1125\left(\frac{.011}{3.8}\right)\left(\frac{.03}{1.1}\right) = .0888$$

$$S_o = \left(1 - \frac{70{,}600{,}000}{254{,}000{,}000}\right)(1 - .30)\frac{1.1}{1.27} = .437$$

About the Authors

LT. COMDR. F. WARNE GOOCH, JR., U. S. Navy, attended Westminster College at Fulton, Mo., and the University of Oklahoma, where he received a B.S. Degree in petroleum engineering in 1940. Upon graduation he was ordered to active duty with the Navy and spent 42 months in the Pacific Theatre in the Submarine Service. He was selected for graduate work in Naval Engineering at the U. S. Naval Postgraduate School, Annapolis, Md., in 1946. In 1947 he was sent to the University of Oklahoma for advanced work.

MARSH S. WATSON, JR., attended Texas A. & M. College and in 1946 received a B. S. Degree in petroleum engineering from The New Mexico School of Mines. He worked as petroleum engineer for Continental Oil Company in New Mexico and The Texas Petroleum Company in Venezuela. He is now attending the University of Oklahoma School of Petroleum Engineering on a Shell Oil Company Fellowship established for candidates working toward a master's degree.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Water Conditioning Study

By ANTHONY GIBBON
Mid-Continent District Editor

THE AUTHOR highlights the work now in progress to determine basic data for bettering the treatment of water for repressuring or secondary recovery use. Although the studies are still under way, a number of general observations have been established and are here presented which will eliminate or reduce trouble being encountered by many.

A STUDY of plants used in conditioning water for subsurface injection to be used in the secondary recovery of oil by water-flooding, in the maintenance of reservoir pressures, and in brine disposal projects, is under way at the Petroleum Experiment Station of the Bureau of Mines at Bartlesville, Okla., in cooperation with the Kansas State Board of Health, the State of Oklahoma and the North Texas Oil and Gas Association. To date, complete studies have been made on 15 water conditioning plants. Nine of the plants tested are located in Kansas, three in Oklahoma and three in the North Texas area. Tentative arrangements have been made to test other plants in these general areas and it is likely that the study, which was started in December, 1947, will continue until late next fall, after which a report will be prepared. The data obtained so far in the study breaks down into the classifications shown in Table 1.

The dual purpose of the investigation is (1) to evaluate the respective efficiencies of different methods of conditioning various kinds of waters in the Mid-Continent area and (2) to investigate the possibility of improving and simplifying existing methods of water conditioning.

Two of the major problems confronting water-flood operators are the corrosion of pumps, pipe, and other metallic equipment by the water injected, and the plugging of oil sands or restricting of line pipe and tubing by suspended matter, precipitates, or organic matter in the flood water. Chemical corrosion results chiefly from the presence of the dissolved gases, oxygen, free carbon dioxide, and hydrogen sulfide. Electrolytic corrosion is severe where two dissimilar metals are in contact with each other in the presence of an electrolyte. Plugging may be caused by the precipitation of suspended matter, by iron, carbonates, sulfates, or other ions which are converted from a soluble to an insoluble state by oxidation or other chemical reactions, or by the deposition of organic matter.

The tests made by the Bureau in the present water study were selected to evaluate the water or waters used from the standpoint of their relative corrosive and plugging characteristics. All corrosion tests and analyses to determine unstable constituents are made in the field, at the plant sites, to obtain more accurate results (Figure 1). Many of the methods and some of the equipment used for the field tests were devised and modified to obtain maximum simplicity, rapidity, and adaptability to waters with high concentrations of dissolved salts and gases.

Corrosion tests and chemical analyses are made in the field in a portable laboratory mounted on a 2½-ton truck. Figure 2 shows the interior of the field laboratory truck. Analytical equipment, reagents and glassware either are permanently positioned in the truck, or may be packed away in drawers to prevent breakage during transit.

FIGURE 1 (inset above). Method of corrosion testing and sampling at a water-injection well. Photo Courtesy Bureau of Mines.

Quantitative analyses are made to determine dissolved oxygen, free carbon dioxide, hydrogen sulfide, pH value, total and dissolved iron, alkalinity to phenolphthalein and methyl orange as calcium carbonate, supersaturation of carbonates as calcium carbonate, hardness as calcium carbonate, chlorides, residual chlorine and turbidity. Microscopic examinations also are made to determine the types and approximate quantities of organic matter present. Samples of the water from the several sampling points are obtained at the conclusion of the tests for complete mineral analyses at the Experiment Station at Bartlesville.

Two types of injection systems generally are used for waters which are to be injected into subsurface formations. In the closed systems, oxygen in the form of air is excluded from the water to prevent the oxidation of low-valence soluble compounds to insoluble compounds which might precipitate solids in the injection system or formation, causing restrictions or plugging. Better efficiency is obtained with a closed system if the water is maintained throughout the system under the pressure necessary for its production, rather than releasing it to atmospheric pressure and later increasing the pressure at the injection pump, as changes in pressure affect the solubility of dissolved gases which also may cause the precipitation of solids.

In the open system, no attempt is

made to exclude air from the water. Rather, the water often is aerated to remove hydrogen sulfide and free carbon dioxide, to effect the removal of ferrous iron compounds by oxidation to the ferric state, and to increase the stability of the water with respect to carbonate constituents. Aeration usually is followed by treatment with lime which raises the pH value of the water, promoting better coagulation, and reacts with any free carbon dioxide which may not have been removed by aeration. Lime also tends to further stabilize the water and removes additional dissolved iron by the formation of ferric hydroxide. A coagulant is employed in most water conditioning systems to hasten the flocculation and settling of finely divided suspended solids. Some of the coagulants used are aluminum sulfate, ferric chloride, ferric sulfate, ferrous sulfate, and sodium aluminate. Coagulation normally is followed by sedimentation, either in ponds or in tanks containing baffles which increase the detention time of the water in the tanks. In nearly all open systems, the water is filtered through filter tanks or beds of crushed rock and sand or finely-divided anthracite coal. Both open and closed filter tanks are used. From the filter, the water passes to a clear water storage tank or pit, from which it is pumped directly to the injection wells by pressure pumps. If organic matter is present, some forms of chlorine, copper sulfate, or other algaecides or bactericides are used. Quite frequently, corrosion inhibitors such as sodium hexametaphosphate (Calgon), sodium silicate, or formaldehyde are added. Many modifications of both the closed and open type systems are encountered.

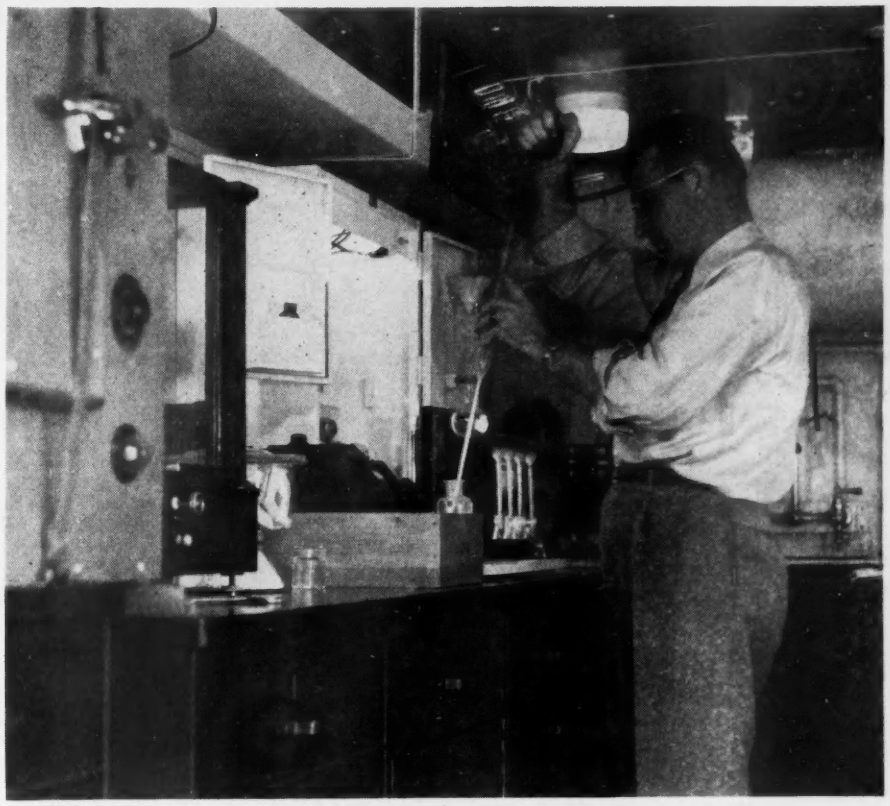

FIGURE 2. Interior of Bureau of Mines field laboratory truck used in the field to test water used in water-injection operations.

Photo Courtesy Bureau of Mines.

Plants studied are selected to obtain information on typical installations using different methods of conditioning for the various kinds of water, as well as installations with any new or unusual features. When a plant is selected for study, and the permission of the operator obtained, sampling valves are installed in the plant process piping to sample the water or waters before treating and at all points in the treating system where any change in the characteristics of the water might occur, including one or more of the injection well heads. A special 72-hour corrosion test as well as a number of chemical analyses are made on samples from each of the sampling points over a period of approximately one week. Complete engineering data on the treating and injection system also are taken.

The data obtained in the study are

■ CONTINUED ON PAGE 157

TABLE 1

KIND OF WATER INJECTED															
Surface water and return water			Surface water only		Surface water, ground water and return water		Ground water only		Ground water and return water						
4			1		1		2		7						
Source of surface water							Source of ground water		Source of ground water						
Rivers	Lakes	Municipal					Arbuckle Limestone		Arbuckle	Other					
2	1	1	1		1		2		5	2					
TYPE OF SYSTEM															
Closed Systems							Open Systems								
2							13								
METHODS OF CONDITIONING USED															
Aeration					Chemical Treating				Sedimentation		Filtration		Deaeration		
10					15				10		14		1		
Tray	Spray	Blower	Cascades		Lime	Coagulants	Corrosion Inhibitor	Algaecides & Bactericides	Ponds	Baffled Tanks	Open	Closed			
5	2	1	2		10	11	3	4	6	4	5	9			
Coagulants Used					Corrosion Inhibitors Used				Algaecides and Bactericides Used						
Alum	Ferric Chloride	Ferric Sulfate			Formaldehyde		Calgon		H T H	Chlorinated Lime	Formaldehyde				
9	1	1			2		1		2	2	1				

NOTE: Numbers in above table refer to number of plants studied.

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The Cameron Non-Lubricated Type "LP" (Lift-Plug) Valve presents a revolutionary approach to the problem of quality valve design. It combines the advantages of recognized plug, gate, and globe valves, and eliminates the generally recognized difficulties of the standard valve designs.

Need for lubrication, which is essential to the operation of the usual plug valve, and generally accepted as an improvement in gate valve design, is eliminated in the "LP" Valve for two reasons: First, a complete seal is effected when the valve is shut, because a portion of the exterior surface of the removable seat is exposed to pressure, thus permitting a pressure sealing action; and secondly, the plug is lifted straight away from the seat before rotation to prevent scoring or galling of the seating surfaces. In addition to eliminating the need for lubrication, the pressure sealing action of the seat and plug forestalls many of the difficulties experienced with conventional designs in all types of valves where distortion of the body due to pressure, temperature, or line strains ordinarily cause imperfect sealing. The lift and turn mechanism incorporated in the valve not only acts to eliminate the need for lubrication but makes possible an extraordinary ease of operation, since operating effort goes first into lifting the plug straight off the seat then into turning it while free from contact with the seat, and, finally, reseating without rotation. In all pressure ranges, the plug rotates in accurately aligned bushings to effectively prevent contact during rotation of the sealing surfaces. Since the seat is a separate piece, which may be removed from the body, it is perfectly feasible to replace both the seat and plug in the field under ordinary conditions. The separate seat and plug are normally furnished in corrosion resistant materials, and may be supplied from almost any material as required for unusual corrosive or erosive service.

A large part of the experimental program for the "LP" Valve was devoted to the development of techniques for producing all of the parts as forgings. The plug and seat, bonnet, cam, cam shaft, and cam housing are drop forgings. The press forge technique used in producing the body represents the accumulative experience gained in the production of the more complex forgings which have replaced castings in most of Cameron products.

Left—The plug actuator is an innovation in valve design. Rotating the operating shaft clockwise three-quarters of a turn first lifts the plug, then rotates it a quarter turn to open position, then seats the plug. Counter-clockwise rotation three-quarters of a turn performs the reverse operation, lifting, turning to closed position and reseating.

Right—The separate seat is also a unique feature of this valve. When seated, line pressure automatically tightens the seal because the pressure is outside a portion of the seat, forcing it into tighter contact with the plug. Being separate from the valve body, the seat, as well as the plug, may be easily replaced in the field.

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- LIFT-PLUG—a novel mechanical design lifts, turns and reseats plug in continuous turn of a lever.
- RENEWABLE SEAT AND PLUG—easily replaced when damaged; permits any desired trim.
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Mitigation of Oil Field Corrosion

By PAUL L. MENAUL
Stanolind Oil and Gas Company

DISCUSSING THE effect and cost of corrosion, the author points out underlying causes and describes methods for coping with the trouble. In particular he stresses the use of the aldehydes as inhibitors, illustrating his point by photographs of serious damage sustained before treatment was begun.

WERE it proposed to levy a tax of a half-billion dollars annually on the oil industry, that would command the immediate consideration of the industry's management. Yet the tax has been levied and is paid every year, but serves no useful purpose. This tax is corrosion, a hidden tax. The oil industry suffers a loss of a half-billion dollars annually due to the ravages of corrosion which attack all types of equipment, including pipe lines, tanks, oil well equipment above and below ground, and refinery equipment. Anderson[1] very clearly stresses the importance of combating corrosion, and other able corrosion engineers have continued to bring this point home to the industry's management and to conduct exhaustive lines of research in attempts to cut down this heavy economic loss.

Iron in the form of mild steel is the major structural metal of the oil industry. The iron age, in which we live, may perhaps be superseded by an age of light metals. Whether this happens or not, all metals used for structural material are base metals, having a considerable tendency to corrode. The object of corrosion research is to devise means of reducing the rate of this process. The tendency of a metal to corrode may be expressed in terms of the intensity of the energy set free when it converts from the metallic state back to the combined or oxidized state, i.e. the relative corrosion tendency is measured by the *electrode potential*. Metals can be arranged in the order of their electrode potential, termed the electro-chemical series.

The over-all grouping of corrosive reactions that affect oil field equipment are:

1. Recombination with oxygen,
2. Recombination with hydrogen sulfide, and
3. Reaction with acids.

The three foregoing reactions liberate hydrogen which is absorbed by iron causing:

4. Hydrogen embrittlement.

These reactions also produce electric currents which are observed as electrolytic currents, or galvanic currents, which also cause corrosion.

When speaking of electrolytic and galvanic currents, some confusion has existed regarding the distinction between the two and the results to be expected from each as far as corrosion is concerned. As used here, the difference is that in galvanic corrosion the closed system supplies its own current in the same manner as a battery, while in electrolytic corrosion the current is supplied from an outside source.

The presence of moisture, an electrolyte or water is necessary for corrosion to take place.

At the beginning of corrosion at any particular installation, there may be only one of the above corrosive agents active on any one piece of equipment, but during the life of the well, other corrosive agents may become active. While one corrosive agent may not cause extensive damage in a short period of time, a combination of several corro-

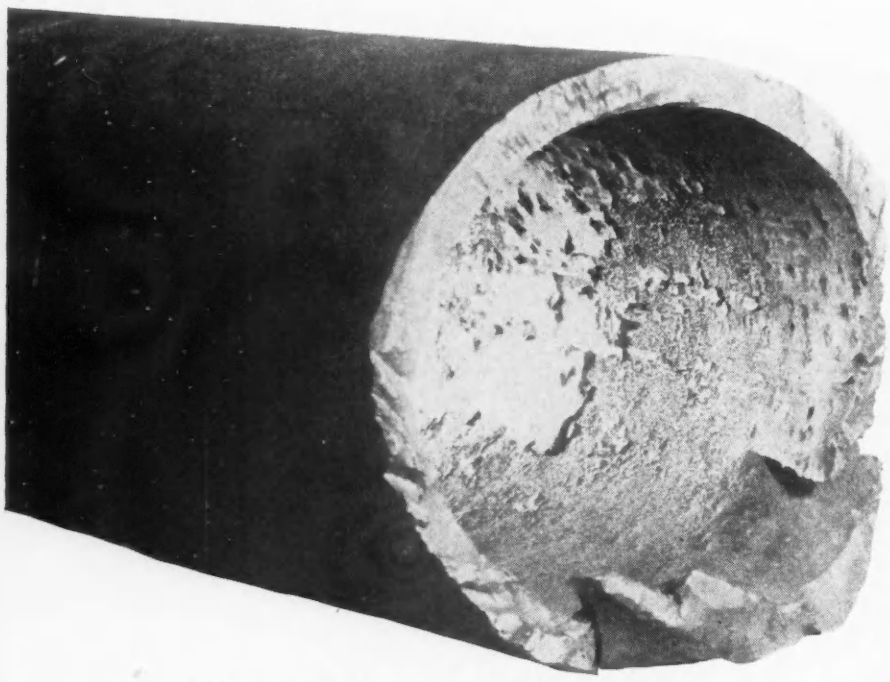


FIGURE 1. Corrosion of drill pipe. Oxidation corrosion.

sive agents will greatly intensify corrosion damage. The *combined* action of *two corrosive* agents may be ten times the sum of the action of the two agents acting singly. This is demonstrated by the intensified corrosion underneath scale which falls from the upper deck to the bottom of stock tanks. The corrosive action of the brine on the tank bottom is intensified by the galvanic action of the foreign scale on the metal. The same is true of hydrogen sulfide corrosion and the galvanic action of the resulting iron sulfide scale on the metal. This combination of chemical corrosion from hydrogen sulfide and galvanic corrosion due to scale has resulted in the perforation of oil well casings in West Texas and New Mexico.

The products of oxygen corrosion and sulfide corrosion are not soluble in water or oil and remain as a scale, which sets up a galvanic cell with the metal underneath.

The severity of corrosive attack is due to factors which influence the rate of chemical processes. We cannot change the direction of a chemical reaction, but we can change the rate of chemical reactions. Corrosion control involves the use of practices to reduce the rate of these reactions and to reduce the area of metal affected.

FIGURE 2. Corrosion of the interior of casing in the gas space. Hydrogen sulfide corrosion intensified by galvanic corrosion.

Practices of Corrosion Prevention

These practices include:

1. The application of protective coatings on metal. This practice is most effective in protecting the exterior of pipe lines, storage tanks, and surface equipment. The application of a thick coating of coal tar is used to protect the lower deck of tanks.
2. The use of inhibitors:
   (a) Oxidation Inhibitors—Chromates and nitrates are added to water to inhibit rusting as in radiator solutions and gasoline plant water cooling systems.
   (b) Acid Inhibitors—
      (1) Arsenic compounds
      (2) Amines (organic nitrogen compounds)
      (3) Mercaptans (organic sulfur compounds)
   (c) Sulfide Inhibitor.
      (Sulfide corrosion may occur in acid, neutral, or slightly basic solutions.)
      1. Aldehydes
      2. Cyanides
3. Neutralization of organic acids in well production. It should be noted that practices 1 to 3, preventing liberation of atomic hydrogen, prevent hydrogen embrittlement.
4. Insulation.
   Insulating flanges are installed in flow lines to stop the electrolytic currents from entering the well.
5. Removal of scale and corrosion products, and
6. Fabrication of equipment from metal or alloys of the same electro-potential when immersed in brine (to eliminate galvanic corrosion).

Protection of Field Equipment

1. Drill Pipe.
   Drill pipe is affected by oxygen corrosion. Most of the action occurs on the interior of the pipe (Figure 1) while out of the hole. The interior of the drill pipe should be washed free of mud to allow rapid drying, at the same time applying a rust inhibitor.
2. Stock Tanks.
   Exterior—Aluminum paint and galvanizing protect the tank exterior from atmospheric corrosion.
   Interior—The upper decks are affected by oxygen and hydrogen sulfide corrosion. Aluminum is resistant to oxygen and sulfide. Aluminum upper decks in use 15 years in sulfide areas are still in good condition. An insulating strip should be laid between the aluminum roof and steel staves.
   The lower decks are affected by sulfide brines and scale which falls from the upper deck. A thick application of coal tar affords good protection.
3. Pipe Lines.
   Exterior is affected by soil corrosion, involving the action of oxygen and acids.
   Protection is afforded by coating with coal tar preparations and wrapping with asbestos or glass fabric; paper wrapping decomposes. Cathodic protection is used to protect holidays.
4. Well Equipment in Sulfide Areas.
   Casing
   Exterior is affected by (1) acidic waters, (2) ground waters containing oxygen, and (3) electrolytic currents. Insulating flanges should be installed in the flow lines. A good cement job reduces corrosion from connate waters.
   Interior is affected by hydrogen sulfide corrosion where moisture condenses. This may be very serious in the gas space of the annulus. (Figure 2) If a packer is used, the annulus may be filled with sweet oil.
   Tubing
   Exterior is affected by sulfide corrosion and resulting iron sulfide galvanic corrosion where moisture condenses on the outside of the tubing, as on top of collars in the gas space. Therefore, where there is danger of the casing being perforated from the inside, an examination of the outside of the tubing should indicate the condition of the inside of the casing. (Figure 3.)
   Interior is affected wherever sour

brines contact the pipe. Brine breaks out of emulsions during shut-down time. Such corrosion may be effectively reduced by aldehyde treatment.

Rods

Hydrogen sulfide corrosion results in pitting of the rods. The hydrogen liberated in the corrosion reaction is absorbed by the iron resulting in hydrogen embrittlement. Repeated stressing of the rods accelerates the growth of fatigue cracks as shown by the characteristic square breakage of rods. Treatment with aldehydes is effective.

Rod boxes are often galvanic to the rods. In such case, the boxes should be replaced by those made of the rod metal.

5. Pumps.

Pumps are affected by hydrogen sulfide corrosion. Aldehyde treatment may be used.

Pumps are often fabricated of a chrome-plated working barrel, (Figure 4) mild steel body, cast iron cages, stainless steel ball and seat, all of which form galvanic couples when immersed in brine. All parts should be made of materials having the same electrical potential when immersed in brine.

Importance of Subsurface Corrosion

The destruction of subsurface oil well equipment by corrosion is such an important factor in the operation of many oil fields, that any method of reducing this economic loss claims the interest of all oil operators. The destruction by corrosion of subsurface equipment is frequently more rapid and more difficult to combat than on surface equipment. The destruction of subsurface well equipment may result in:

1. The cost of new equipment
2. The labor cost of replacing the equipment
3. The cost of a repair or workover job on the well
4. The permanent loss of valuable oil or gas
5. The possible damage to the producing reservoir
6. The loss of production during the workover operation

Subsurface oil well corrosion may be divided into two major types: (1) high pressure condensate well corrosion, caused by the presence of organic acids in the production, and (2) sulfide corrosion, caused by the presence of hydrogen sulfide and soluble sulfides in brines.

Economics of a Planned Corrosion Control Program

A planned corrosion control program can result in rather large monetary savings in a very short time. Such a planned corrosion control program was instituted by the Stanolind Oil and Gas Company in the sulfide producing fields of Kansas.

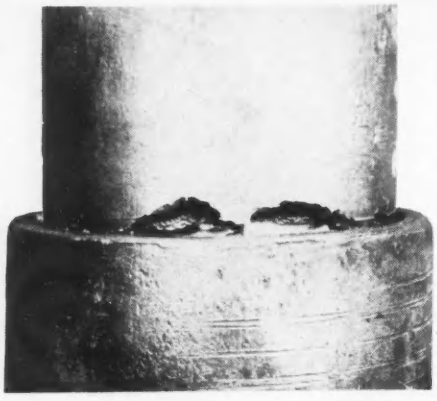


FIGURE 3. Corrosion of the exterior of tubing in the gas space. Hydrogen sulfide corrosion intensified by galvanic corrosion.

The evaluation of the results of treating the sulfide wells of Kansas has been presented by Walter C. Pearson,[3] who stated that treatment of 325 wells over a period of three years has resulted in average savings of $50 per well per month.

A recent field engineering report shows that the successful results with formaldehyde continued through 1948 and up to the present time. This report shows at present 334 wells being treated with formaldehyde with a result that pulling costs have been reduced 60 percent. The specific rod replacements in Zenith field in Kansas have decreased 86.8 percent and tubing replacements have decreased 62 percent. Before chemical treatment began, some wells in this field showed a pulling cost of $1000 to $2300 per year. A saving of 62 percent in well expense is a factor in profitable continued oil production from this field. Field engineering reports show that sulfide corrosion damage had reached a high state of activity before formaldehyde treating was begun and that the formaldehyde treatment has reduced these well expenses from $1000 per year to $380 per year. This is an example of the beneficial effects of the formaldehyde treatment of wells that had been producing corrosive fluids for years without any inhibiting treatment, until the equipment was severely damaged and the cost of replacements very high.

The value of beginning the formaldehyde treatment of wells in corrosive fields before the well equipment has been damaged by sulfide corrosion and the galvanic iron sulfide scale formed on the well equipment, was shown in the St. Johns Townsite field. The wells in the St. Johns Townsite field produce brine of the same sulfide content and chemical analysis as those in Zenith field.

The wells in St. Johns Townsite field were drilled and put on production in 1944 and treatment with formaldehyde was started before pipe was appreciably corroded. The cost record of these wells shows that only one well has had rod or tubing replacement to date and the well cost of the field has been the cost of formaldehyde, which is $70 per well per year.

As a result of this observation it would appear advisable to begin formaldehyde treatment of all wells drilled in hydrogen sulfide producing areas as soon as they are put on production, before corrosion has actually become apparent. By the time corrosion has been noted much of the equipment has been damaged.

In treating old wells, it would be advisable to remove adhering iron sulfide scale in order to afford maximum pro-

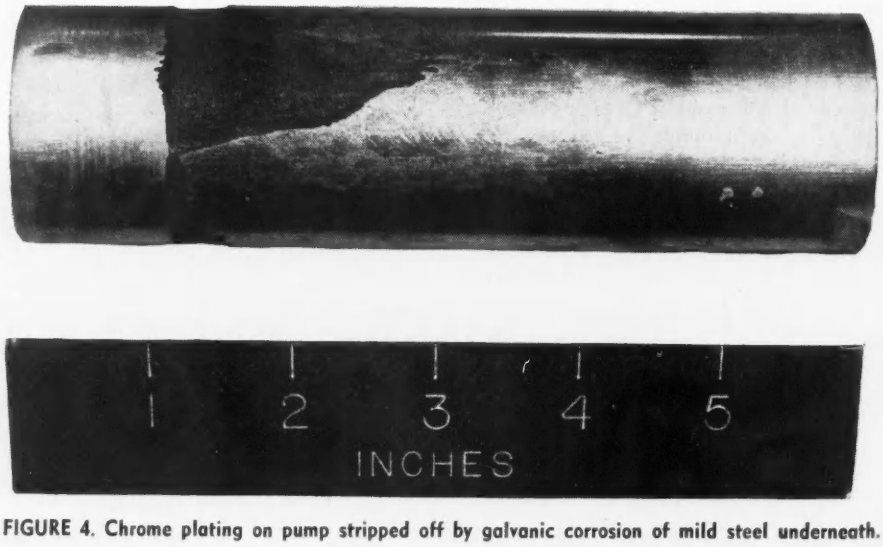


FIGURE 4. Chrome plating on pump stripped off by galvanic corrosion of mild steel underneath.

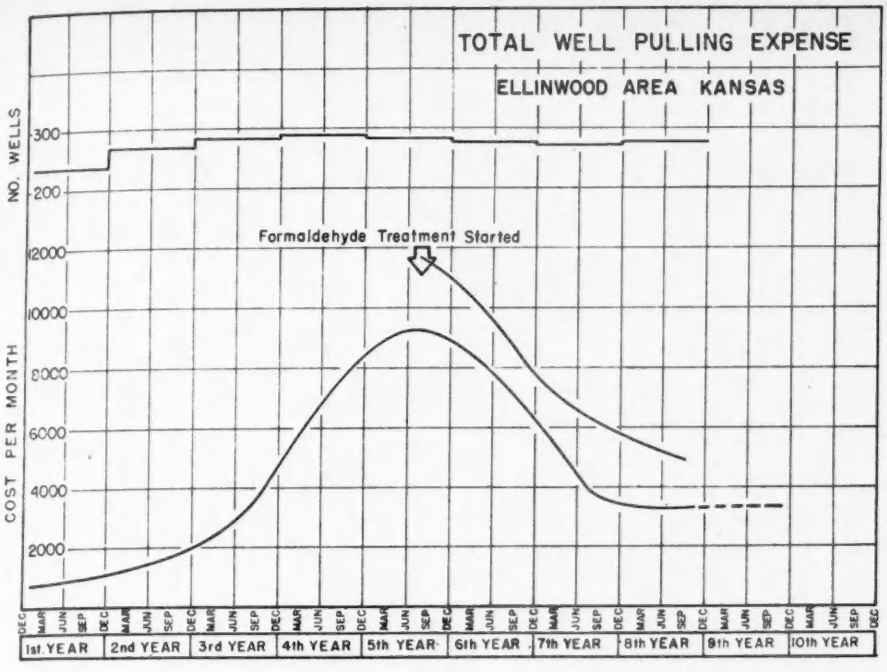


FIGURE 5

tection of the equipment. The iron sulfide scale that has been formed by corrosion would prevent the formaldehyde from protecting the metal underneath the scale and because of the difference in the electrical potential of the iron sulfide scale and the iron underneath, galvanic corrosion could still go on although the well was on formaldehyde treatment. This fact explains the continued although lowered pulling cost of treated old wells.

Pulling Cost Decrease

The Ellinwood area shows a decrease of 60 percent in pulling cost since formaldehyde treatment was started. The wells in the Ellinwood area had produced sulfide brines for many years and suffered severe corrosion before the formaldehyde treatment was discovered. Figure 5 shows that the damage caused by sulfide corrosion increases yearly in geometric ratio, unless the well corrosion is inhibited.

In the tabulation of the Kansas District the ratio of oil to water production is 7700 barrels of oil daily and 43,000 barrels of water, showing the important fact that the formaldehyde treatment is effective in wells characterized by a large water production and high hydrogen sulfide contents of the brine.

In treating wells with formaldehyde for inhibition of sulfide corrosion, as reduced to practice by field personnel, a field survey is made first to identify potentially corrosive wells by determining the presence of H_2S, the volume of brine produced is determined, and the H_2S content of the brine and pH value of the brine as produced at the well head are measured.

Formaldehyde is a gas dissolved in water; the usual commercial product contains 37 percent formaldehyde. Recently a technical grade containing 25 percent formaldehyde has been put on the market. As a rule the following treatment is recommended: When 25 percent formaldehyde is used, two quarts per well per day is recommended as a minimum; if the well produces more than 75 barrels of water per day, then one additional quart of formaldehyde is added for each 35 barrels brine produced daily. The dilution of the required amount of formaldehyde to a total volume of three gallons is advisable to reduce the tendency of the formaldehyde to vaporize, and to carry the chemical to the bottom. Another method using about five gallons of well fluid for flushing the formaldehyde down the casing is also used. This is a matter which can best be worked out in the field.

The formaldehyde solution is batch injected into the casing annulus through a chemical feeder having a valve below and above the container.

The well casing should not be open to the atmosphere; the entrance of air or oxygen into the casing annulus will cause corrosion.

ACKNOWLEDGMENT

The author expresses appreciation to the Stanolind Oil and Gas Company for permission to present this paper.

REFERENCES

[1] H. H. Anderson, The Oil Weekly, Apr. 21, 1947, P. 58.
[2] Walter C. Pearson, paper presented at the Mid-Continent Division of API, Spring Meeting, 1948.

Water Conditioning Study

■ CONTINUED FROM PAGE 149

still incomplete and no specific conclusions can be drawn or recommendations made from them. However, the following general observations may be made from the information at hand.

1. It is very important to analyze and evaluate the water available for flooding purposes thoroughly and carefully before the treating plant is designed and constructed.

2. Routine tests to determine pH value, alkalinity and carbonate stability, and free chlorine content (where chlorine is used in any form) should be made quite frequently, preferably daily. Frequent determinations of iron, dissolved oxygen, free carbon dioxide, and hydrogen sulfide also should be made.

3. Corrosion is in general a more serious problem in the Mid-Continent area than is plugging.

4. Closed systems are applicable with waters having negligible or very low acid gas (free carbon dioxide and hydrogen sulfide) concentrations and low iron contents.

5. A greater detention time in sedimentation ponds and tanks, also in clear water storage pits and tanks, is needed in many plants.

To obtain further information concerning the relative importance of the dissolved gases, oxygen, free carbon dioxide, and hydrogen sulfide in promoting the corrosion of iron and steel, laboratory equipment is now being assembled for a study which will supplement the data obtained in the field studies. Corrosion specimens will be exposed for varying lengths of time to waters in which all variables promoting corrosion such as pressure, temperature, velocity of the water, duration of exposure, and constituents of the water, except the dissolved gas concentrations will be kept constant. De-ionized water and brines, containing varying concentrations of the dissolved gases singly, and in different ratios of the gases, will be used as the corroding medium. A system is planned in which no metal other than the corrosion discs are in contact with the water, thereby eliminating as nearly as possible the chance for electrolytic corrosion.

Another study which tentatively is planned to closely follow and correlate with the dissolved gas study concerns chemical and physical means of removing dissolved oxygen from fresh waters and brines.

It is hoped that the information obtained in these studies will be of value to all operators, engineers and chemists concerned in any way with the secondary recovery of petroleum by water flooding.

Theory and Practice of *Water-Flood Operations*

By M. H. STEKOLL
Stekoll Petroleum Company

THE AUTHOR studies various types of flow possible in a water-flooding project, particularly in the areas where his company operates, and develops the theory that under certain flow conditions a water-input well may profitably be converted to a producer, despite the fact that such a conversion may violate the geometric symmetry of the input pattern.

ACCORDING to radial flow theory, water entering uniform permeable formations from an injection well will flow more or less uniformly in all directions from the well bore. The pattern of flow, therefore, will cause a circular area of water to be formed around the injection well while oil is forced ahead of the water in a concentric ring. As a result, the sand into which water has penetrated becomes filled mainly with water and residual oil. The concentric ring area ahead of the watered section is filled with oil and connate (interstitial) water. This area immediately ahead of the watered out section may be called the area of "oil fill up," (Figure 1.) As the watered-out zone expands with added water injection, oil is continually forced ahead, causing a growing concentric ring of oil fill up. The oil is forced by the four injection wells to the center of the five spot and out the producing well. Calculations of the time required to fill up a particular five spot may be made when sufficient reservoir data are available. Essentially, the amount of water required to fill a five spot (Table 1) will be equal to the "gas space" (pore space minus reservoir oil and connate water), or produced oil volume corrected to reservoir conditions.

It is commonly considered that uniform sand conditions are required to obtain consistent radial flow patterns. In many areas sufficiently uniform conditions apparently exist to permit the fluid flow to follow essentially radial flow conditions. In other areas sufficient variations in formation character and flood development exist to create non-uniform flow conditions of fluids through the formation. Permeability changes through the sand body both horizontally and vertically are effective in causing deviations in fluid flow from radial theory.

The differences in permeability vertically through the sand body may be seen in most published permeability profiles as determined by core analysis. The matter of relative permeability is not considered as erasing permeability variations shown by air permeabilities, but merely to indicate different values that remain non-uniform.

Also, permeability values may change horizontally through the sand. Water penetrating a 200-millidarcy streak at the well bore may encounter 50 md. a few feet from the well bore. The sand immediately below this section may be of reversed conditions, that is 50 md. at the well bore and 200 md. a few feet out. The water in the first section may migrate down to the second section and travel out the second section, vertical permeability permitting. This condition may exist in a formation to a large or small extent with the water traveling from an injection well following an inconstant path. The significance of these and other variable formation conditions shows up in fluctuation of producing well history, resulting in non-uniform well decline curves, and enabling other changes to be made from normal operation methods that will be noted later.

Pressure Problem

The condition of differing formation pressures caused by the injection well drilling and water injection program may cause serious change in the flow of water from an injection well, especially when the property to be flooded is of sufficient area that all the injection wells cannot be drilled at the same time or water injection may not be started economically into all wells simultaneously and uniformly.

Assume a group of injection wells are drilled as shown in Figure 2 and water started into each well. Under flowing conditions the formation pressure may be considered to approximate the hydrostatic head plus injection well head pressure, or some value between this pressure and the shut-in producing well head pressure plus hydrostatic head. For a hydrostatic pressure of 500 pounds and a well head pressure of 500 pounds, the formation pressure as a result of water injection may be built up to the order of 1000 pounds. In many old fields, where water flooding is practiced, the reservoir pressure before flooding may be as low as 20 pounds. Whatever the formation pressure is before flooding, it is generally only a fraction of the assumed 1000 pounds. After fill-up and 1000 pounds or comparatively high reservoir pressure is achieved, the water from the outer row of injection wells is pushing against high pressure toward the center of the developed area, and against low pressure toward the area not under flood. Even in sands of lower permeability, for example under 100 to 200 md., it may be expected that the effect of the pressure difference will be great and that water from the outside row of injection wells will flow primarily toward the low pressure area and away from the high pressure area. Under these conditions the water from the outer row of injection wells may be considered as following linear or stream flow rather than radial flow. As a result of following the permeability variations in the sand, this outward flow of water may be irregular both horizontally and vertically.

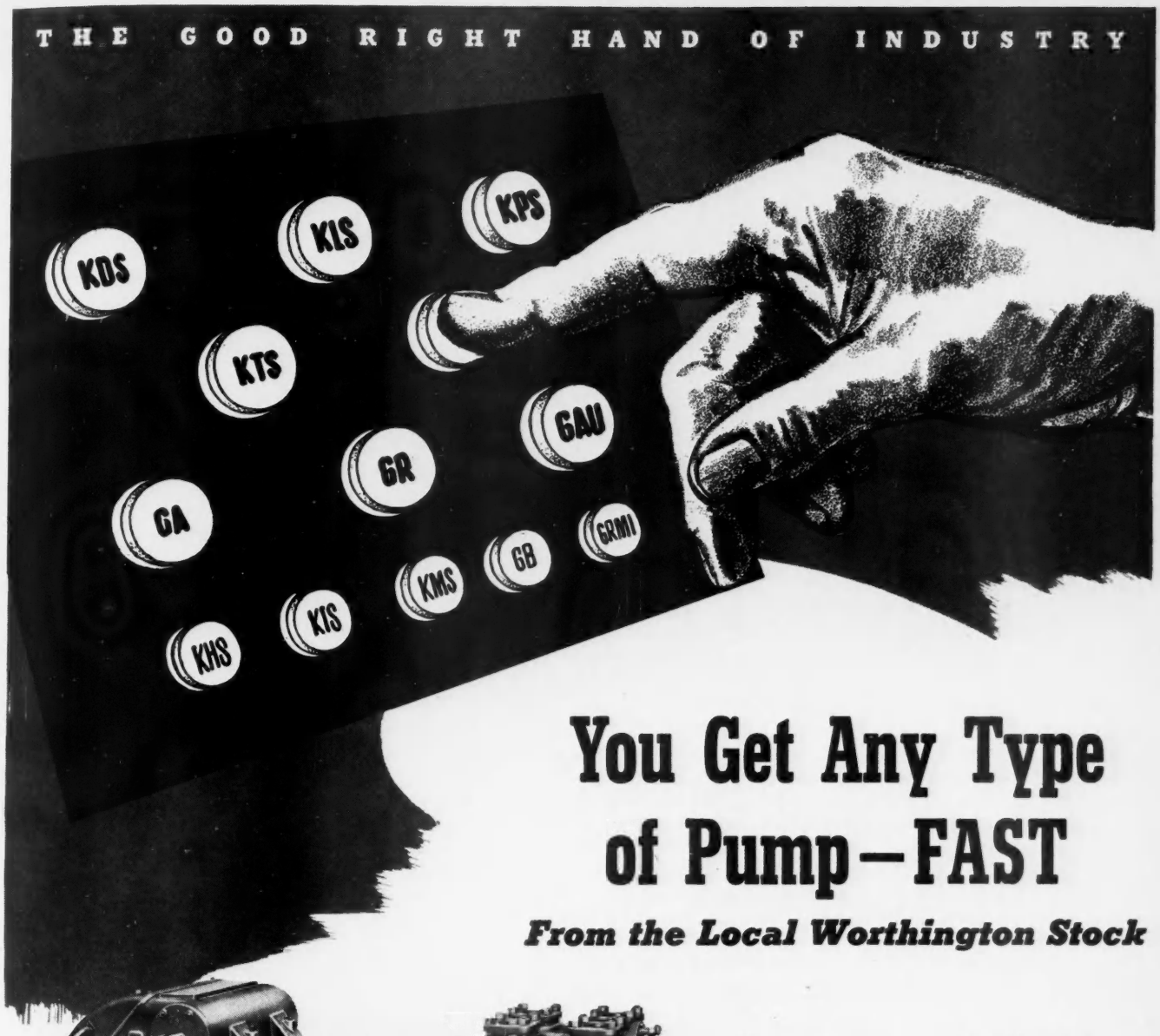
As additional rows of injection wells are drilled around the original water injection area, the water flowing outward from the former outside injection row may be partially retarded in the outward flow direction by water from the new injection wells. Water from the new injection row will flow radially until pressure from the original flood will cause flow to be diverted outward away from the flood area.

In the calculation of Table 1, for radial flow, 60,000 barrels of water are required to fill up the void or gas space in the five spot.

The value of 60,000 barrels per injection well may be considered as applicable, for example, to the injection wells around producing well No. 9, Figure 2.

After fill-up is obtained, producing well No. 10 is drilled and the two injection wells 3W and 4W are drilled,

THE GOOD RIGHT HAND OF INDUSTRY



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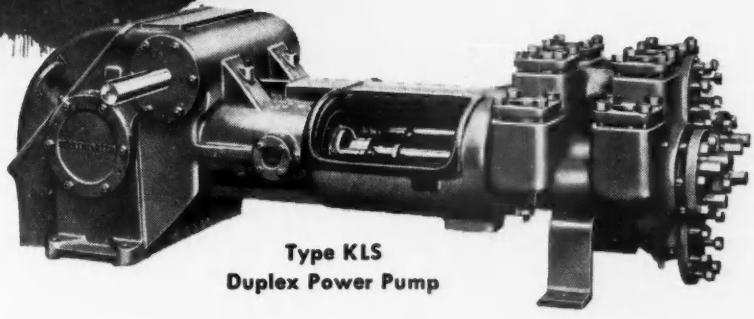

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Figure 2. As injection is continued, the water injected into 1W and 2W may be considered as going outward away from the flood, as shown by the arrows. Under initial conditions the water from an injection well may be assumed as divided into fourths, one-fourth of the injection going to each of the producers around the injection well. In wells 1W and 2W, after fill-up is obtained in the initial flood area, the water from 1W may flow 50 percent toward producer No. 10 and 50 percent toward producer No. 11. Water from injection well 2W may flow 33⅓ percent toward each of producing wells Nos. 10, 12 and 13. Therefore, fill-up in the No. 10 five spot will be obtained more rapidly than would be anticipated if only 25 percent (¼) of the injection of each well is considered as going to each producer.

Even with pumping operations, in many reservoirs, the formation pressure in the original flood area will be sufficiently higher than in the undeveloped area that the fluid flow from the outer row of injection wells will be primarily outward.

Under these conditions of varying pressures and permeability the oil may be entrapped or pushed into any area or series of areas in the field. The center of the five spot may be water productive and the edge of the five spot oil productive. Also, with unequal pressure development, the flow of oil may not be toward the center of the five spot, but may be of linear nature or a condition approaching a concept of streams or slugs of water, which in turn may be followed by streams of oil. If the water

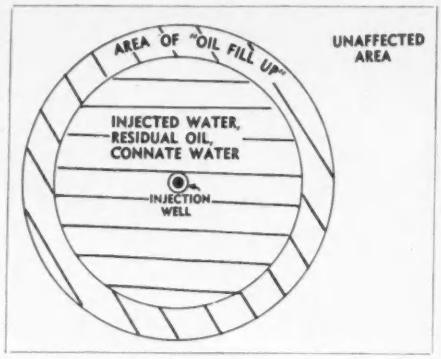

FIGURE 1

from an injection well is flowing in one direction, out away from the high pressure area, it is possible that oil, also flowing out from the high pressure area, may be flowing in stream fashion directly past the outside injection well and joining the flow of water from the injection well.

Variables in reservoir pressure and permeabilities may eliminate ideal radial flow to a large or small degree in a flood. If such irregularities are discovered in a flood, the regular five spot development may be no longer significant. There may be no need for exact spacings in the development program if the injected water follows no regular pattern after leaving the injection well bore.

The practical aspects of these considerations are definite and under certain conditions may result in increased oil recovery or decreased development and operation costs.

As an example, an injection well location may be drilled to extend the previously developed flood. If the original flood has high reservoir pressure the newly drilled injection well may flow when drilled in. If the new injection well flows water, it may indicate that the water is streaming past this location and the well is at a good location to inject additional water. On the other hand the well may flow oil and the hole may be used preferably as an oil well.

If such a hole, flowing oil when drilled in, is used as a water injection well, the water injected may simply enter the oil stream and continue to move in the same direction as the flow of oil. In such a well the oil would not be diverted in direction of flow by the injected water to any marked degree and the well could be converted to an oil producing well even after water has been injected for a period of time. If, for example, the flow past the well is from south to north, the injected water may continue to flow from south to north. If the well is converted to a producer, the direction of flow through the sand body may remain unchanged and the water injected into the well, which we assume has moved north of the injection well, will not be moved back south to the converted well. Such a well therefore, even after having several thousand barrels of water injected into it, may be converted to a producer.

Table 2 shows typical histories of two such injection wells converted to producers.

Under conditions of stream or linear flow in the formation, the relative pressures in parts of the sand body may change as the flood progresses, creating changes in the flow of fluids through the reservoir. Since the flow of oil and water through the sand is controlled to some extent by these pressure differences, the changes in these pressures may divert the stream of oil or cause the streams of oil to be erratic and perhaps to be broken by volumes of water, following which are additional volumes of oil. Variable flow conditions of this sort are significant in operating a flood. A well may decline in oil production and increase in water production until the economic limit is considered to have been reached. If erratic flow of fluids in the formation is recognized, the well may be shut in as a temporarily abandoned well with the realization that while the well is shut in the flow of fluids past the well bore may continue and that there remains the possibility that oil will be pushed past the well bore in the future. Since we are dealing with a complicated and fluctuating condition of formation fluid flow, oil may never be found at the location of the shut-in well, or it may be found in a month, a year, three years, or even longer.

Further, it may be realized that a well may have more than two productive

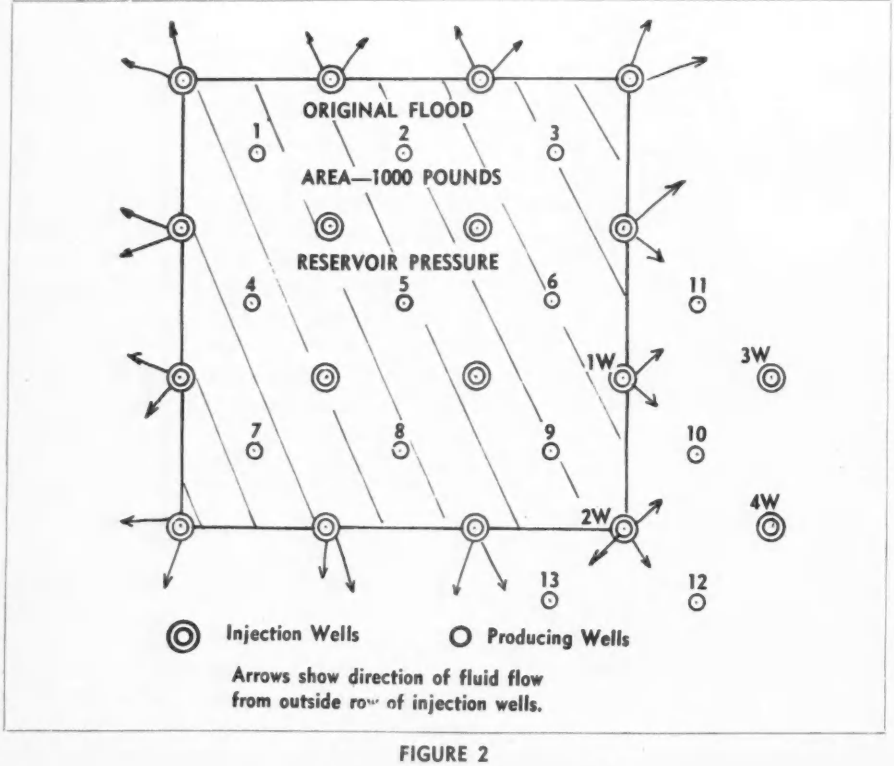

FIGURE 2

THAT HAS A HIGH WATER-OIL RATIO

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—Complete V-belt drive including both driving and driven sheaves and V-belts.

—Selected radiator type cooler for compressor cylinders, and air-cooled intercooler coil complete with centrifugal circulating pump.

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—Fuel gas pressure regulator and Volume tank.

—Welded and flanged gas line connections.

—Thermometer, and Thermometer Welds in all lines.

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***—Automatic Speed and Pressure Controls.*

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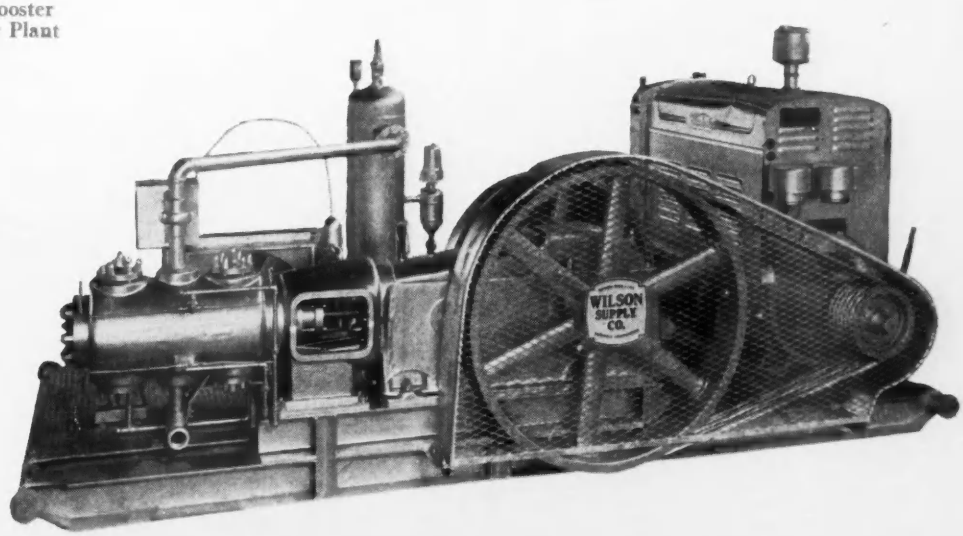

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cycles. Suppose oil is found in a shut-in well and the well is opened to production. After a period of time has elapsed the well will decline again to the economic limit and again be shut in. The entire cycle may or may not be repeated another time depending on the accidental conditions of interacting pressures and fluid flows, Table 3.

Following the line of thought of irregular fluid flow and streams of oil and water occurring in variable fashion, it is possible that an injection well showing water on flowing test at one time may show oil production at a later date. If the oil production is sufficient, it may be advisable to convert the injection well to a producer for as long as oil continues to be produced at the location.

Since excessive backflowing of injection wells is not advisable as water and pressure are lost from the pay and since sudden backflowing may cause certain formations to cave in or slough, the backflowing tests of injection wells may be confined to approximately once per year depending on field conditions.

Shut-in producing wells may be tested several times per year as the lack of water injection into these wells possibly permits the re-entry of oil into the area with greater ease than where water is being injected. This is an inexact and approximate type of problem where any rules followed are subject to the experience derived for the particular area under study.

In flowing a shut-in well or injection well to test for oil production, it is advisable that sufficient time be allowed for the tubing and bore hole to be emptied of fluid so that the fluid actually passing through or in the sand is allowed to come to the surface. Stable conditions of flow may be reached in an hour or a day depending on field conditions and rate of flow.

Obviously conditions of radial flow and uniform fluid flow are to be desired. Where these conditions are not obtainable practically or economically, it may be advisable to take the oil out of the flood area from wells wherever they are located and whenever the oil is forced around these well bores. When stream or linear flow is considered as existing, then nearly any old well, almost regardless of location, may be suitable as a producer or injection well sometime in the flood history, providing other formation conditions permit the use of the old wells.

The procedure of plugging a well, whether at a small or large distance from the center of the five spot, may not be profitable in certain areas. If it is believed that a well in the center of the five spot is desirable, then the old producer may be tubed and saved as a shut-in well in the event oil should occur under the area where the old producer is located. However, if stream flow is the prevalent type of flow in the flood area, the concept of regular five spots may be dropped completely and a concept substituted whereby sufficient input wells are used to drive the oil and create adequate formation pressure. Sufficient oil wells must be made available, by drilling new wells or cleaning out old holes, to provide outlets for the oil. That there are any rules regarding the comparative number of oil and water injection wells is not apparent. This should be determined by field experience, with an open mind toward this "rule" of water flooding being maintained at all times.

Under linear and erratic flow conditions, and where sand conditions permit, the development of an old field may be carried out by using old holes almost entirely without drilling any new wells except for field extension work, or to obtain core data, or to provide additional wells where old drilling was too widely spaced. By using old holes either as injection or producing wells, and by limiting new drilling to the absolute minimum, some areas may be flooded economically where new drilling would prohibit development and flooding. In many areas, the use of old holes, even where the old holes have been abandoned and must be cleaned out, may result in a 50 percent or more reduction of development cost. Such a large saving in developing a flood may be critical in many fields, and the re-drilling of a field should be undertaken only after a complete study has indicated that such drilling is necessary and economic.

Water flooding is a rather new type of oil operation and is particularly new when considered in the light of published data. Many floods are carried out without sufficient data accumulated to determine proper type of development and operation. The ideas regarding stream or linear flow are presented merely to indicate some of the problems encountered in flooding operations.

TABLE 1

Sample calculation for time required to fill a 5 spot

Assume

1. 660-foot spacing between injection wells, or 10 acres per 5 spot.
2. Connate water saturation of 30 percent of pore space
   Oil saturation in the formation at start of flood of 50 percent of pore space
   Total fluid saturation in formation of 80 percent of pore space
   100 percent of pore space minus 80 percent equals 20 percent of pore space, which is "fill-up space."
3. Porosity of 1500 barrels per acre foot. Then "fill-up" is 20 percent of 1500 or 300 barrels per acre foot. For 10 acres, fill-up is 3000 barrels per foot.
4. 20 feet of sand. Then 20 feet x 3000 barrels per foot is 60,000 barrels of water per injection well to obtain complete fill up.

TABLE 2

Conversion of Injection Wells to Producers

Well No. 1

Used as injection well from January, 1946, to February, 1948.

Total water injection—54,774 barrels. Average well head pressure during injection—700 pounds per square inch.

Converted to producer February, 1948.

Cumulative oil production, February, 1948, to February 1949—7794 barrels.

Cumulative water production February, 1948, to February, 1949—13,500 barrels.

Present production rate:
Oil —18 barrels per day
Water—32 barrels per day

Well No. 2

Used as injection well from March, 1946, to January, 1948.

Total water injected—27,639 barrels. Average well head pressure during injection—750 pounds per square inch.

Converted to producer January, 1948.

Cumulative oil production, January, 1948, to February, 1949—2520 barrels.

Cumulative water production, January, 1948, to February, 1949—21,000 barrels.

Present production rate:
Oil — 2.0 barrels per day
Water—21.0 barrels per day

TABLE 3

Example of producer with two productive cycles

Cumulative production January, 1945, to February, 1947:
Oil — 11,060 barrels
Water—109,000 barrels

Well shut in February, 1947, making
Oil — 0.0 barrels per day
Water—160.0 barrels per day

Well tested each month from February, 1947, to November, 1948. Test each month showed:
Oil — 0.0 barrels per day
Water—160.0 barrels per day

In December, 1948, well tested:
Oil — 5.0 barrels per day
Water—140.0 barrels per day

Production for December, 1948, January, 1949, February, 1949, totals 450 barrels of oil
Present production rate:
Oil — 5.0 barrels per day
Water—140.0 barrels per day

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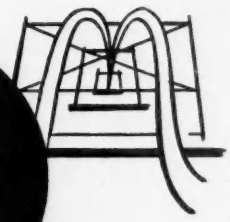

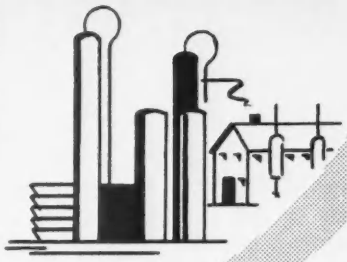

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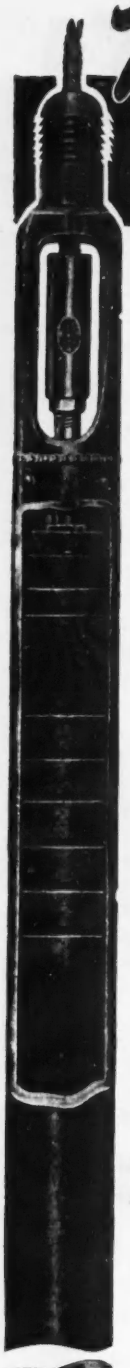
Miller

SAND PUMPS

Standard Clean-out Tool for 25 Years



Check any oil field in the world where sediment or sand is met with and you'll find Miller Sand Pumps and Bailers are standard . . . leadership earned and held by continuous improvements during 25 years of service!

The Miller Sand Pump is made in Regular and Heavy Duty types in sizes listed below. Lug type Chisel, Sand and Bailer Bottoms are easily interchanged.

Threaded Chisel and Sand Bottoms can be supplied, to permit larger pieces of sediment to pass, and pump to be dumped without removing bottoms. Tool Pin bail allows tools and sand pump to be run on same wire line when desired.

Write for new descriptive price list on Miller Sand Pumps and Bailers. See Composite Catalogue page 2666 for details.

SAND PUMP AND BAILER SIZES:

Outside Diameter
2½"
3"
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5½"
7"

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20 feet
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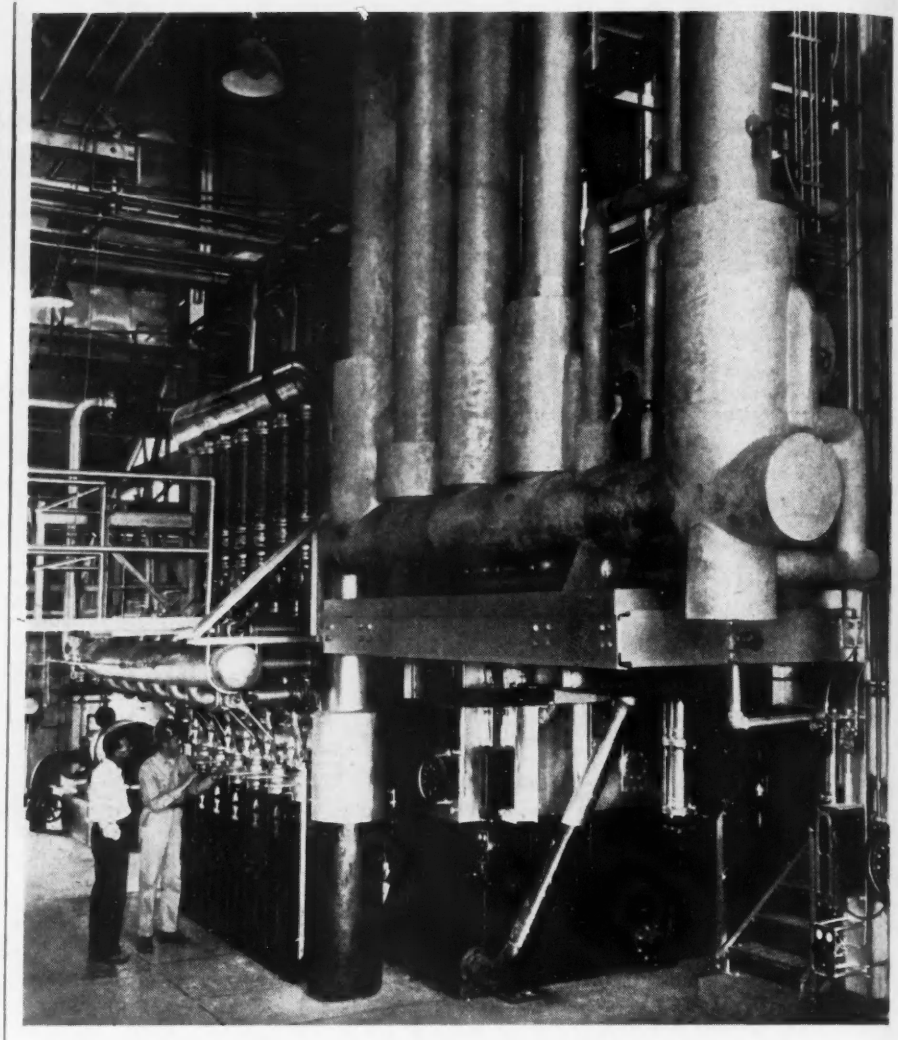


Stanolind engineers, Richard Lyon and Merle Rahmes, inspect the inert gas generator.

Boiler Generates Inert Gases For Injection at Elk Basin

A SPECIAL boiler generates 15 million cubic feet of inert combustion gases daily at the Elk Basin plant, near Powell, Wyo., for injection into the Embar-Tensleep reservoir in the Elk Basin field. This practice is expected to materially increase the recovery of crude. Because the casinghead gas produced in the field is insufficient to carry out an adequate injection program, and since neither outside gas nor water was economically available, engineers of the interested companies decided on the inert gas system as the best way to carry out the project.

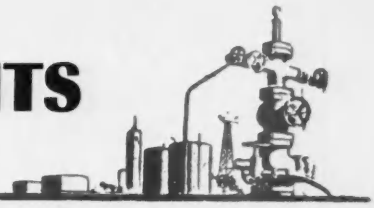
In the boiler, residue gases are burned under close combustion controls to produce a gas that is free of oxygen and about ten times the volume of the gas burned. The boiler also generates about 52,000 pounds per hour of steam for processing and plant and field power.

Besides the pressure maintenance program, the Elk Basin plant incorporates two other major conservation features. It extracts and recovers butane, propane and natural gasoline from the casinghead gas and produces great quantities of sulfur from the hydrogen sulfide in the gas.

The plant was designed and built by Stanolind Oil and Gas Company and the 29 other working interests in the field under a unit agreement.

How to do it!

PRODUCTION HINTS

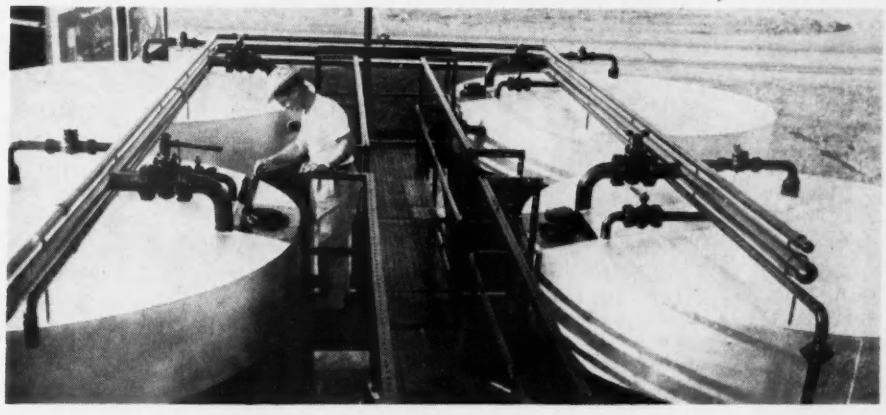


$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas.

HOW TO—Prefabricate Simplified Tank Piping

Simplified tank piping which includes a gas line for "rolling" tank bottoms may be shop fabricated and taken to the field and flanged with a minimum of labor and fittings. Oil flows from the gun barrel from left to right around the header line, and into the tank being filled. The vent line connects in the center between the tanks and runs to each of the tanks then to the left to the flume on the gun barrel.

The smaller two-inch line inside connects to the separator vent line and runs to the bottom of each tank where it turns at right angles. When a high bottom is encountered in a tank, the valve at the top is "cracked" and the tank agitated while the bottoms are pumped back through the treating system.



Since the tanks are all welded and the same distance apart and level, the piping is made up at the shop and the holes cut into the top of the tanks and the pipes welded in the correct position. This is done before oil enters the tanks. Flange valves are used so that connections may be taken apart at any time.

HOW TO—Build Efficient Service Truck Hoist

The field mechanic who makes the rounds of pumping wells often encounters a lifting job which he is not able to perform without aid. To save considerable time, for he sometimes is miles away from the nearest shop or field office, one company equips its field service trucks with a light chain hoist assembly.

The hoist consists of an upright length of 2½-inch pipe supported in a socket welded securely to the rear end of the truck frame and to the back end of the steel-clad bed. Inserted in this upright is a length of two-inch pipe, to the top of which is welded a horizontal 36-inch length of 2½-inch pipe. Inserted in this horizontal arm is another length of two-inch pipe, to the outer end of which is welded a heavy eye. The hook of the chain hoist is hooked into this eye.

To provide maximum "reach" for the hoist, when it is impossible to back up the truck close to the job, the horizontal arm can be telescoped out for a foot or two and locked into position with T-handle set screws welded to the outer member of the horizontal arm. These same set screws hold the telescoping sections together when the unit is closed up in the over-the-road traveling position.

To provide additional height for the hoist, such as when lifting a cylinder head or radiator from an elevated engine, provision is made for the telescoping upright section to be raised and locked into two higher positions. The diagonal brace, a one-inch round steel bar which helps to support the horizontal arm, is bolted to one of three holes drilled through the sides of two parallel flat bars welded to the side of the main vertical member. If the telescoping section is raised another foot or two, the brace may be bolted in the new position and still have as much strength as it had in the lower position.

The hoist will lift a 500-pound load with safety.

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REFLEX and TRANSPARENT
DROP FORGED STEEL LIQUID LEVEL GAGES

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REFLEX
Drop Forged Steel Liquid Level Gage
Empty Space Shows White Liquid Shows Black

Due to "Reflex" principle, liquid always shows black and empty space white. Liquid level is indicated instantly and unmistakably. Made of temperature resisting alloy steel for high pressure and temperature service. Conforms with API and ASME requirements.

PENBERTHY
TRANSPARENT
Drop Forged Steel Liquid Level
GAGES

Glass front and rear permits observation of color and density of liquids under high pressures and/or temperatures. Highest quality—made of temperature resisting alloy steel. Conforms with API and ASME requirements.

3277-C

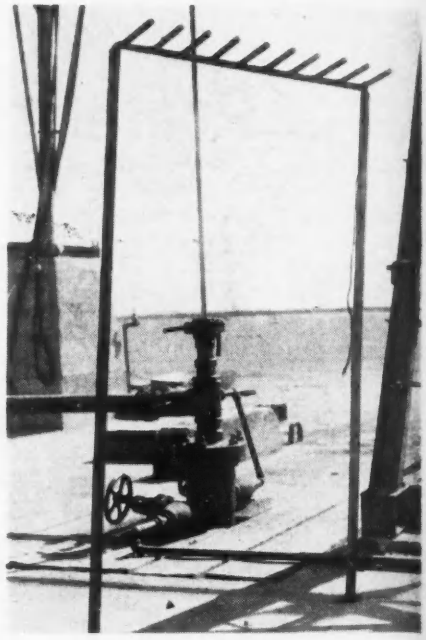
PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant—Windsor, Ontario

HOW TO—Build Sucker Rod Hanger

Various methods are employed when sucker rods are pulled to hold back the lower end of the "bundle" so as to keep the rods back out of the way of men working in the vicinity of the well head. One company developed an unusually simple and inexpensive device that requires a minimum of materials and time to construct.

At the desired distance back of the well head two holes are drilled into the concrete mat, and upright lengths of 1½-inch or two-inch pipe are inserted in them. Any convenient length of pipe may be used, the average ranging from six to nine feet long. Distance between the pipes is determined by the number of rods that normally will be used in the particular well. Across the tops of these upright standards is placed a horizontal rod of solid round steel to which have been welded, at about six-inch interva'ls, short pieces of sucker rod material as shown. This horizontal rod, each end of which is bent downward through 90 degrees, is inserted in the tops of the two upright pipes.

The completed assembly, shown in the position most commonly employed on a well, is neat in appearance, is easily disassembled for transfer to other wells and requires a minimum of material to construct. When rods are pulled, they are racked in the individual spaces, thereby simplifying the counting and inspection of individual rods as they hang in the rack.



HOW TO—Use Winch to Make Digger

Where it is necessary to run telephone lines or power lines along the rights-of-way, a means must be provided to dig the post holes by power. One company makes use of a power take-off, front end winch, and differential from an automobile as shown to dig such holes. One side of the differential is blanked off and an eye welded on for a hoisting hook. The other contains the connection for the drill pipe. Drill pipe such as used in shot holes is used, and a regular rotary digging tool is connected to the bottom. The boom over which the winch line passes is tall enough to allow a full joint to be run and then another joint attached much the same as in shot hole drilling.

The digging tool is turned by means of a power take-off from the transmission of the truck and a shaft running to the front of the truck. From there, two universal joints and a drive shaft con-

nect it to the elevated differential gears. The boom which holds the differential is separate from the elevating boom and serves to keep the drill pipe vertical and solid. This rig may be used for drilling shallow water wells where the water table is high and the digging is easy.

HOW TO—

Make Portable Gas Meter Run

Where one meter is used to measure the input gas for several wells, portable meters are usually used with an orifice flange at each well. A completely portable unit having a flange moved with the recording gauge may be made by installing the meter on a short two-inch nipple with quick-acting unions at each

end. These unions are the same distance apart at each well and a nipple is used on the wells when the meter is not installed.

When a periodic gas-oil-ratio test is to be made, the gas is shut off for a few minutes and the quick-acting unions are broken loose with a hammer. The meter run is then inserted into the line and the flanges are hammered again.

The support for the meter is welded directly to the portable meter run, and two pieces of angle iron are saddled under the run to facilitate leveling the meter. Loops of sucker rod material are welded to the tops of the angle iron for use as handles in moving and setting up the meter. The piping, of course, connects directly to the orifice flange and need never be broken between settings.

AXELSON
FIRST CHOICE

AXELSON Deep Well Plunger Pumps deliver more oil at less lifting cost with less down time. There is an Axelson Deep Well Plunger Pump for every specific well condition.

AXELSON Sucker Rods backed by 56 years of factory know-how, are duty designed, service proved under every well condition, making them "First choice" in the Petroleum production field.

AXELSON PETROLEUM PRODUCTION EQUIPMENT

WRITE FOR BULLETINS ON: Sucker Rods and Couplings, Pump Liners, Pump Plungers, Balls and Seats, Specific Deep Well Plunger Pump Assemblies, Long Stroke Pumping Units, Pumping Accessories.

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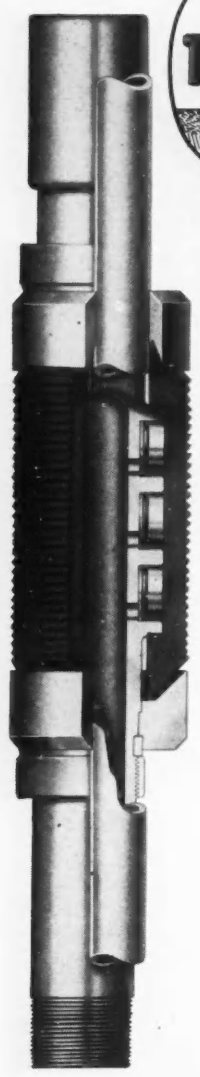
HOW TO—Make Positive Choke Tool

A quick-acting choke wrench may be easily made of materials around the lease to facilitate the changing of choke inserts. A regular choke bar is cut in half and the corners turned off on a lathe. A piece of one-inch pipe is slipped over the reduced section. An 18-inch piece of sucker rod material is welded across the top and bent up on one end to form a crank. A six-inch piece of three-quarter-inch pipe is slipped over the end, and the tip of the sucker rod material built up with the torch to allow it to turn without slipping off.

The wrench is then ready for operation. As soon as the cap is removed from the positive choke assembly, the wrench is inserted and the sucker rod handle used to break it loose. As soon as the insert is broken, the crank is used to whirl the insert out and the new insert is whirled back in place. This tool saves much time when it is necessary to change the positive choke and eliminates shutting in the well for more than a few moments.



PAGE TYPE "C" TUBING ANCHOR

PAGE TENSION TOOLS

NOTE ...TO "FREE PUMP" OPERATORS!

SMOOTH OUT YOUR TUBING TROUBLES with this PAGE TYPE "C" TUBING ANCHOR...

It's *designed* for parallel strings!

The Page Type "C" Tubing Anchor is designed specifically to anchor parallel strings in "Free Pump" installations. Its advantages to operators are many. The Page Type "C" Anchor *assures* a fast tubing run-in without danger of accidentally setting slips, *eliminates* the human element of top-hole manipulation in setting and *saves* valuable time in landing tubing strings. The Page Type "C" *relieves* tubing of fluid and working pressure loads and *increases* the factor of safety in long tubing strings. It enables running longer strings of second grade tubing because the Type "C" *supports* the tubing and holds it in tension, free of "working" loads.

SIMPLE OPERATION

The Page Type "C" Tubing Anchor sets hydraulically on fluid pressure differential. The hydrostatic head of oil in the power string together with the "free pump" surface operating pressure, forces a series of small pistons against v-cut slip segments that grip securely against the casing. Holding power of the slips far exceeds fluid head and operating pressure loads. Release and removal from well requires only drainage of tubing. Tool can be run-in either end up.

SIMPLE CONSTRUCTION

Anchor Body made from a solid billet of steel . . . working force consists of two v-cut slips and six pressure-sealed pistons . . . all parts replaceable and interchangeable.

PAGE OIL TOOLS, Inc.
3356 Lime Ave., Long Beach 7, Calif.

WRITE now for details or see . . .

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The Continental Supply Company Dallas, Texas

HOW TO—

Make Rack for Chemical Drum

A drum rack to hold chemical drums can easily be fabricated from scraps of one-inch pipe. Two pieces eight feet long are curved on one end to form the legs of the rack. Two other pieces five-feet long are bent in a U-shape to form rockers for turning the drums down. The ends of the U-shaped sections are

. . . another reason why drillers prefer

Standco
NO-SMOKE

BRAKE LINING

Standco Brake Blocks are made of cabled cords of long fibre asbestos — woven solid and reinforced with bronze wire to prevent pulling loose on the belts. They will not burn or smoke or score brake rims.

More deep wells have been drilled with Standco than with all other blocks combined. It's your answer for low-cost hole-making.

STANDCO BRAKE LINING COMPANY

Factory and General Offices

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L-K THREE RING DOUBLE SWIVEL
(Heavy Type)

This heavy duty (Style No. 104) L-K Three Ring Double Swivel is made of alloy steel, heat treated for strength and toughness, has ball bearings on each end and is designed for spinning line use and for safer faster making up of pipe.

Tested to 10,000 lbs. before shipment — breaking strength 35,000 lbs. Takes line size to 1⅝", length 11¾", weight 4¾ lbs.

See Composite Catalog for L-K Products.

Patented

Ask your supply store or write us for full information.

L-K PUMP VALVE CO.

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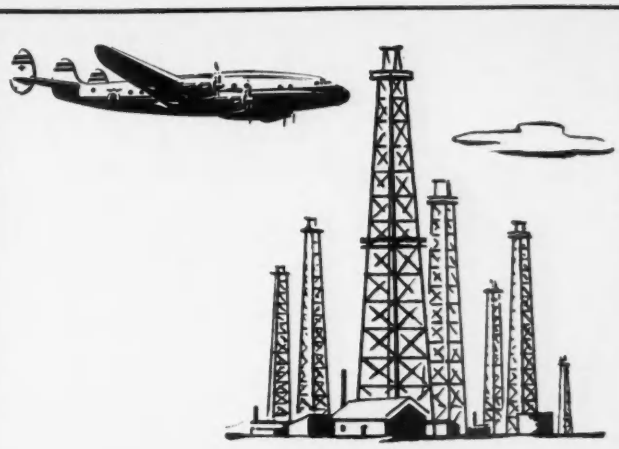

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welded fast to the side pipes and cross pieces are welded in front and back to hold the drum. A chain with a hook on one end is welded to the side piece to hold the drum in place.

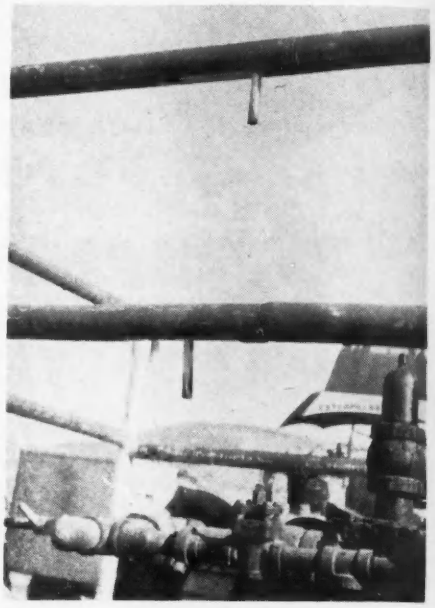
When a new drum of chemical is unloaded from the lease truck, the rack is moved beside it and the chain fastened around the drum. Grasping the ends of the curved side pieces, the pumper lowers the drum into the pouring position. A five-gallon can is used to transfer the chemical to the chemical pump supply chamber, and the can fits easily under the spout of the drum.

This device makes it easy for the pumper to handle the chemical and eliminates the hazard of back injuries which might result from rolling the drum onto a stand.

HOW TO—

Build Two-Bar Well Enclosure

A sturdy enclosure around the well installation, and a simple method of removing it when the well has to be pulled or serviced was provided by an efficient method of constructing two-bar well enclosures. Made of 2½-inch pipe and welded together in the conventional manner, the enclosure was cut apart in



the center of each of two opposite sides. A narrow slot, partly visible in the photograph, was then cut in the under side of each bar on one side of the cut. A short length of two-inch pipe was

inserted in each of the pipe rails, and a six-inch handle was welded to it, the handle projecting downward through the slot as shown. The two-inch pipe, when thrust through the adjoining ends of the railing, effectively held the enclosure together. By sliding it along the length of the slot, a man can lock together or break in half the two sections of the enclosure. When parted, the two half sections can be picked up and laid to one side, providing access to the well by servicing equipment.

HOW TO—

Transport Long Manometer

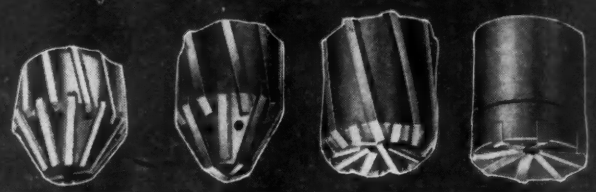
A practical and effective protector for the long glass U-tube manometer which gas field men carry to test well and line pressures was devised by one company and installed on its field vehicles. The protector is a length of 4½-inch boiler tube, slightly longer than the manometer to be carried. Space between the inside of the protector tube and the manometer was padded with two rings of thick four-inch web belting and fastened to the inside of the protector tube by rivets passing through holes drilled in the side wall of the tube about six inches from each end.

The protector tube was then mounted in a vertical position on the vehicle, just behind the cab, by welding one end to the running board. A circular band of thin strap iron was bent around the tube and welded to the corner of the side walls of the truck bed.

A slip-on cover was made by welding a flat steel disc over the end of a five-inch pipe collar. A fastener was made by cutting a hole in the side of the collar and welding a quarter-inch threaded nut over the hole. The tightening screw was a quarter-inch set screw with a short piece of small-diameter welding rod welded to its head to form a T-handle. A lifting bail was made from a piece of welding rod bent into two 90-degree bends, with the ends welded to the top of the slipon cover.

KINZBACH Whipstocks and Mills-FIRST with oilmen for 24 years

Leading oil operators the world over use Kinzbach Whipstocks for side-tracking, straightening and directional drilling operations. They can be set at any depth, requiring no support for the bottom. Positive setting slips prevent slipping or turning in hole. They can be oriented to mill out in any direction. Patented hinge arrangement assures that top of Whipstock will lie close against pipe walls at all times, permitting easy passage of drilling tools. Setting trigger always locates whipstock between couplings so window will be within one joint. Available in all popular sizes of casing.



Type "A" Mill Type "D" Mill Type "H" Mill Type "I" Mill

Carefully heat-treated high-speed tool steel inserts from the cutting blades in Kinzbach Milling Tools. These inserts, set at most efficient cutting angles in properly shaped, high quality steel bodies provide unequalled cutting action and a uniform depth of cut.

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NORRIS TURNBUCKLES

FORGED STEEL CONSTRUCTION

The sizes available vary from ½" to 2" with bodies for take-up of 12", 18", 24" and 36", with Stub, Hook, Eye, Pull-rod or Clevis ends.

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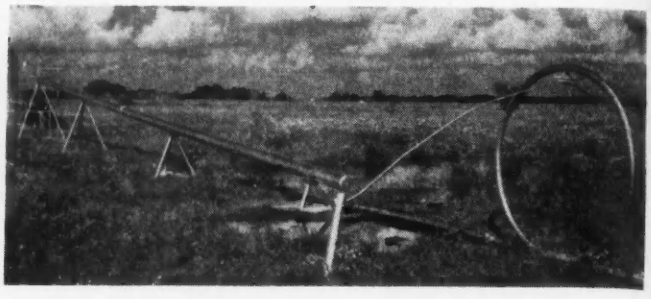
PRODUCTION HINTS

HOW TO—Handle High-Pressure Gas

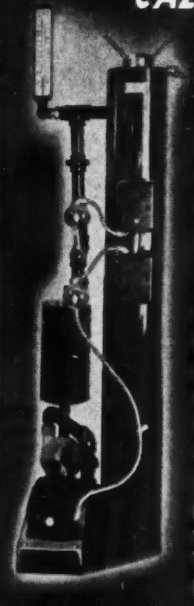


A standardized hookup for connecting high-pressure gas wells, which includes expansion loop, drip, and heater, is shown. The gas well is at the right and the gas passes through each section en route to the meter at left. The expansion loop is made from a joint of two-inch seamless tubing. It is filled with sand to keep it from flattening and bent in a circular shape. Unions are placed at either end to facilitate the installation. The gas enters the drip or scrubber, which is constructed from two joints of oil well casing and mounted on tripods so that one end is several feet lower than the other. Gas enters on the side near the top and a two-inch line runs about a fourth the way down the drip, thus directing the flow of gas downward.

The outlet line with gauge connection is welded to the highest point of the drip, and this line connects to the heater. The heater is the indirect type and the gas flows through coils of two-inch pipe immersed in hot water.

A regulator is installed on the downstream side of the heater and the gas is then measured after reducing the pressure.

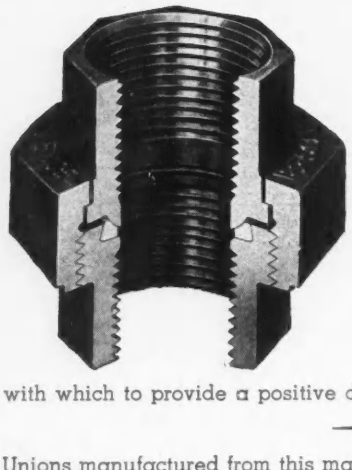
GAGE CALIBRATING BATH



Jacketed and insulated pressure chamber for working at pressures up to 10,000 p.s.i. Heaters and thermostat control temperatures from 100° to 300° F. Heat transfer fluid circulates 5 times per minute. End plug removed without tools. Two 1000 Watt heaters.

COLEMAN INSTRUMENT
and Manufacturing Company
716 SOUTH TROOST TULSA, OKLAHOMA

Jefferson Malleable Unions



JEFFERSON'S *ENDURO* unions available in brass-to-iron, and iron-to-iron seats. Certified Air Furnace iron used in the ENDURO line is A. S. T. M.-4733-Grade 35018 malleable, having a 53000# Min. Ten.
ENDURO—300# S.W.P.—600# C.W.P.

Certified Air Furnace iron produces a constant, uniform, finer grain structure union. This provides a much better iron with which to provide a positive dependable seating surface.

Unions manufactured from this malleable iron afford 30% more strength; 50% more impact value; 75% more elongation. Sizes ¼" thru 3".

Obtainable through your jobber

Jefferson Union Company, Inc.

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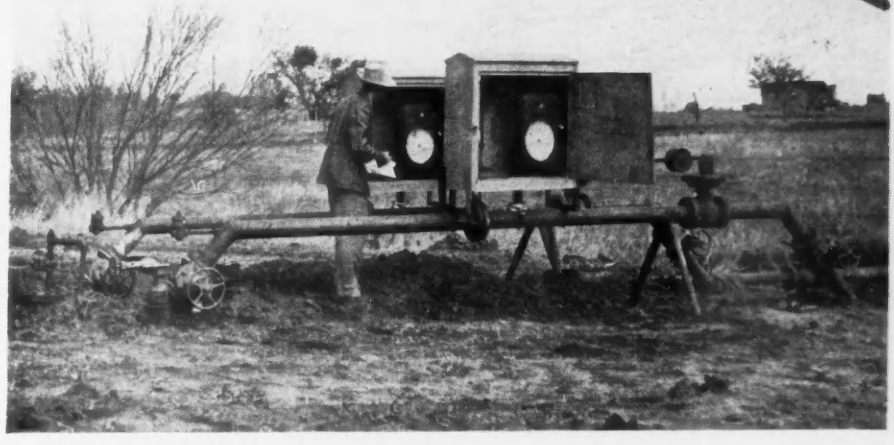
Practical Aspects of Orifice Meter Calculations



By HERMAN A. JACOBSON
Shell Development Company

THE AUTHOR limits his discussion to the primary element, using sharp-edge orifice plates. His presentation is the practical engineer's approach to orifice meter calculations. A few of the important working formulas are reviewed, and a simplified method of calculations presented. Attention is called to lack of information on accuracy and errors and the need for standardization is emphasized. The article is condensed from a paper read at the Semi-Annual Meeting, ASME, at San Francisco June 27.

THE orifice meter, using sharp-edge orifice plates, is one of the most common and inexpensive means of metering fluids and gases, and therefore commands the interest of a great number of engineers.

It is desirable that plant and field engineers should be able to make a simple orifice computation without having to rely upon the instrument specialist. It is understood, however, that if such computations are done mechanically, without grasping the background and basic principles, there is a grave danger of errors. These principles are really quite simple but, unfortunately, are not available in simple form. The AGA-ASME Joint Committee's reports being concerned primarily with research, the source of information that is mostly within reach is a manual from some manufacturer of meters. These manuals furnish as a rule a speedy tool for standard computations but have, in the opinion of the author, two faults: First, the formulas are set up so that all computations are done mechanically, and second, the reader does not readily see the common principle behind them.

To support these statements it can be mentioned that a major oil company published for its own use, in 1936, a guide to orifice meter computations. Its object was, in the words of one executive, "to take the mystery out of orifice metering." The fact that this guide has been consistently preferred to the guides of the meter companies indicates that this object has been attained and that, in spite of all their good points, the editing of these latter could be improved.

Before discussing the flow formulas a word about the nomenclature may be in order. The ASME Standards are complete and logical and the subsequent definitions leave nothing to chance or imagination. It is the understanding of the author that they have been generally accepted as standards. Actual practice reveals a completely different picture, however; a review of actual usages, as observed in the field or in the common manuals, gives a picture of the confusion. (See Table 1.)

A plea is here made for not only the formal acceptance of the ASME nomenclature, but also its actual acceptance in every day usage.

TABLE 1

	AGA-ASME	CNGA	VDI	Meter Manufacturer No. 1	Meter Manufacturer No. 2
Flow Coeff., inc. velocity of approach	K	K	α	E	ϕ
Orifice—Pipe diameter ratio	$\beta\left(=\frac{D_2}{D_1}\right)$	$\beta\left(=\frac{d}{D}\right)$	$\sqrt{m}$	d/D	d/D
Expansion factor for gases	Y_1	F_{e1}	ϵ	....	Y_1
Absolute viscosity	μ	u	n	t_s G	μ
Volume rate of flow	q	Q	Q	V Q	V q

Flow Formulas

The fundamental "Hydraulic Equation" includes the differential pressure expressed as a head of the flowing fluid, h. This differential pressure is for most commercial meters expressed in equivalent inches of water at a standard reference temperature, usually 60° F. or 68° F. The symbol for this is h_w. Still, there are usually a great number of meters

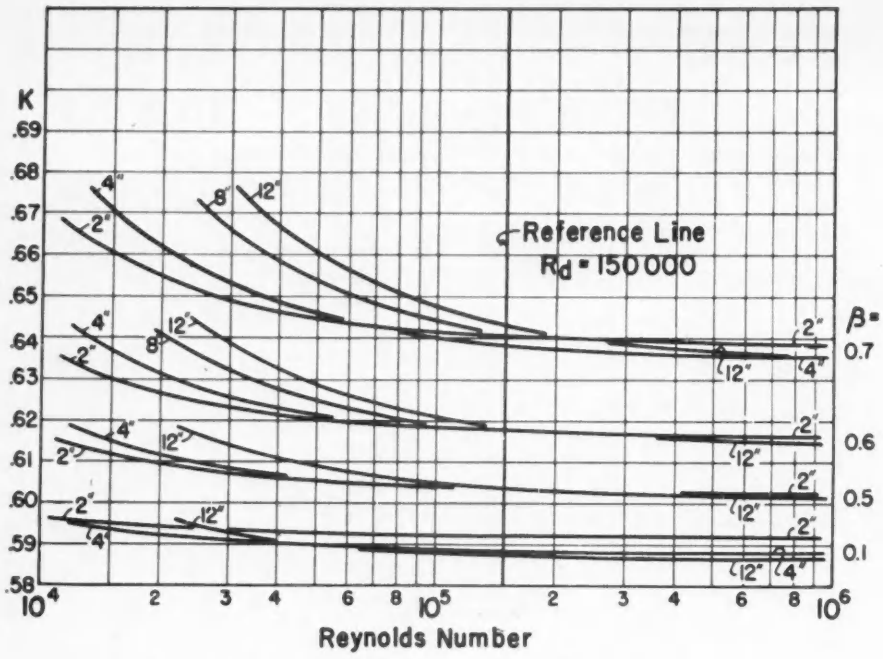


FIGURE 1. Relationship between flow coefficient and Reynolds number.

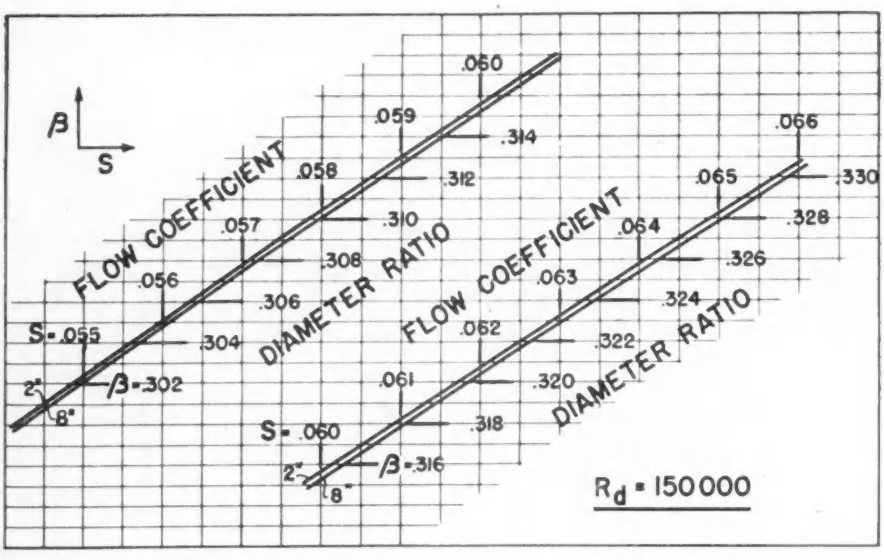


FIGURE 2. Relationship between diameter ratio and flow coefficient, at $R_d = 150{,}000$.

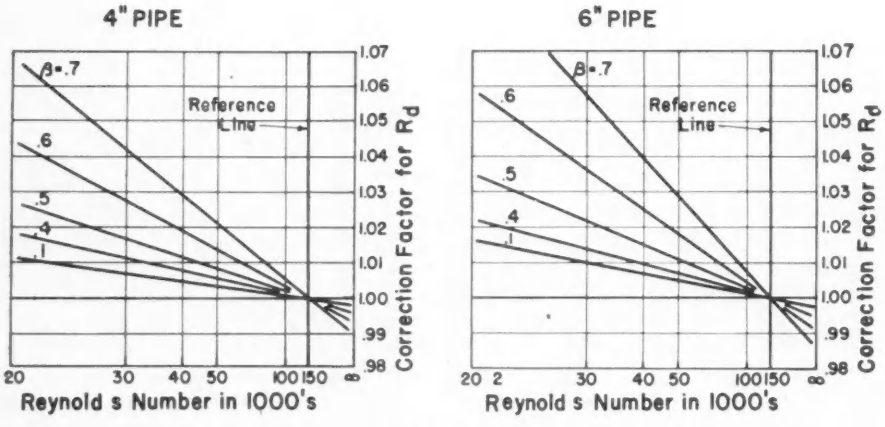


FIGURE 3. Flow correction factor for Reynolds number.

where the differential is observed directly on a manometer, the manometer liquid in most cases being mercury. Adding a sealing liquid between the flowing liquid and the recording liquid, the relationship is,

$$h_w = h_m \frac{\rho_m - \rho_b}{\rho_s} \qquad (1)$$

General Formula

Proceeding to the equations for computing the flow, the general formula for actual flow rate is,

$$q_1 = 0.0997\ K\ D_2^2 \sqrt{\frac{h_w}{\rho_1}} \qquad (2)$$

If the differential pressure is observed directly on a manometer and a sealing liquid is used between the manometer liquid and the flowing fluid, the formulas (1) and (2) can be combined into

$$q_1 = 0.0997\ K\ D_2^2 \sqrt{\frac{\rho_m - \rho_b}{\rho_1 \rho_s}\ h_m} \qquad (3)$$

where,

h_w = Effective differential pressure, inches of water at 68° F.
h_m = Observed differential height of liquid column, inches
ρ_1 = Density of flowing liquid, pounds per cubic foot at flowing conditions
ρ_m = Density of measuring liquid in the manometer, pounds per cubic foot
ρ_b = Density of sealing liquid, pounds per cubic foot
ρ_s = Density of reference liquid, pounds per cubic foot (For water at 68° F., $\rho_s = 62.316$)
q_1 = Flow rate, cubic feet per second at flowing conditions
K = Flow coefficient, including velocity of approach; a function of β, pipe diameter, and Reynolds number
β = Diameter ratio = D_2/D_1
D_1 = Inside diameter of pipe, inches
D_2 = Diameter of orifice, inches

From these formulas any other flow formulas can be developed by conversion and addition of correction factors.

When designing a new orifice installation the flow rate is usually known but the flow coefficient, and thus the orifice diameter, has to be computed. This means that D_2 in formulas (2) and (3) would have to be assumed before K and β can be computed. The pipe diameter, D_1, is however chosen from standard sizes and can be selected with a fair degree of assurance. Therefore, a new flow coefficient, S, will be introduced, defined by

$$\frac{S}{K} = \left(\frac{D_2}{D_1}\right)^2 \quad \text{or,} \quad S = \beta^2 K$$

which changes formula (3) into

$$q_1 = 0.0997\ S\ D_1^2 \sqrt{\frac{\rho_m - \rho_b}{\rho_1 \rho_s}\ h_m} \qquad (4)$$

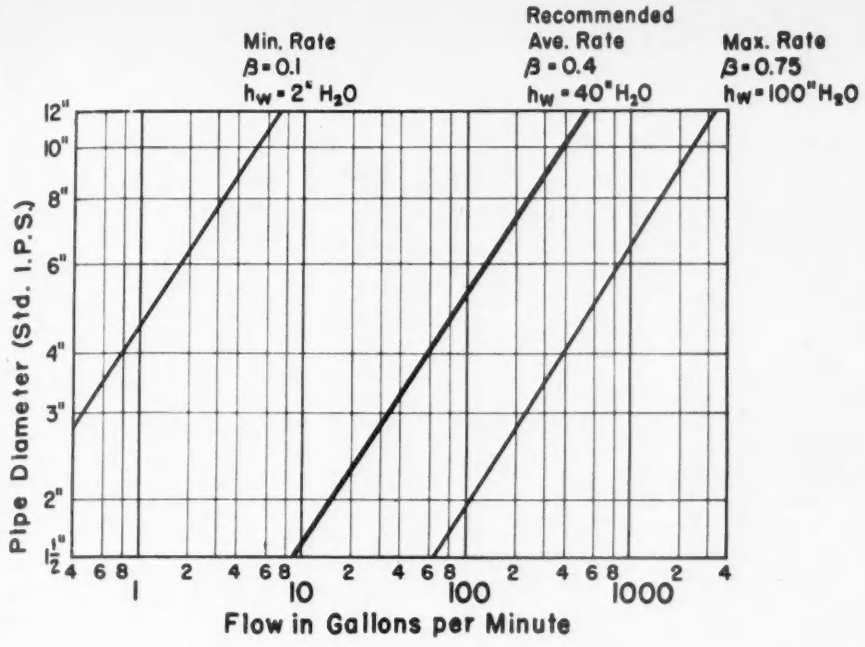


FIGURE 4. Chart for determining approximate pipe size.

The previously stated formulas all refer to general cases. In the following some special cases will be reviewed. The most common one is metering a liquid, where the differential pressure is observed directly on a manometer, with the flowing liquid in direct contact with the manometer liquid (i.e. no sealing liquid). The flow rate will be expressed in the more common unit of gallons per minute (= q'). At the reference temperature 68° F., the formula will be

$$q' = 5.669\ S\ D_1^2 \sqrt{\left(\frac{\rho_m}{\rho_1} - 1\right) h_m} \qquad (5)$$

When metering steam, the flow rate is usually measured in pounds per hour, (= w'). The general formula then changes to

$$w' = 358.9\ S\ D_1^2 \sqrt{\frac{\rho_1\ (\rho_m - \rho_b)}{\rho_a}\ h_m} \qquad (6)$$

In metering gases the formula will have to be modified to include compressibility. The added factors are,

p_1 = Upstream static pressure, pounds per square inch absolute

T_1 = Upstream absolute temperature, °R

Y_1 = Net expansion factor, referred to upstream pressure and density

y = Supercompressibility factor

G = Specific gravity, relative to air

In addition,

h'_w = Effective differential pressure, Inches of water at 60° F. (This is the standard of the gas industry)

q'_c = Flow rate, cubic feet per hour at standard conditions, here assumed at 14.735 pounds per square inch absolute and 60° F.

resulting in the formula

$$q'_c = 2827\ K\ Y_1\ D_2^2 \sqrt{\frac{h'_w\ p_1}{T_1\ G\ y}} \qquad (7)$$

Correction factors, as for temperature, density, base conditions, etc., are considered outside the scope of this summary.

Returning to the general flow equation, the flow coefficient, K, varies with the diameter ratio, pipe diameter and Reynolds number, R_d. Figure 1 shows the relationship between these quantities for a few values of β. R_d is calculated in reference to the diameter of the orifice. It is quite clear from these curves that operation at a low Reynolds number is to be avoided because conditions become too critical. This is particularly the case for large diameter ratios.

Simplified Method

A simplified method of flow computation is here presented. The general method is not new, but it is believed the form here described has not been published and has certain advantages. For an average case it will make the solution by trial and error unnecessary.

A value of Reynolds number is selected, so chosen that it constitutes an approximate average for typical installations. In this discussion this selected value is 150,000. From ASME tabulated values of K, at Re = 150,000, the corresponding S-values have been calcu-

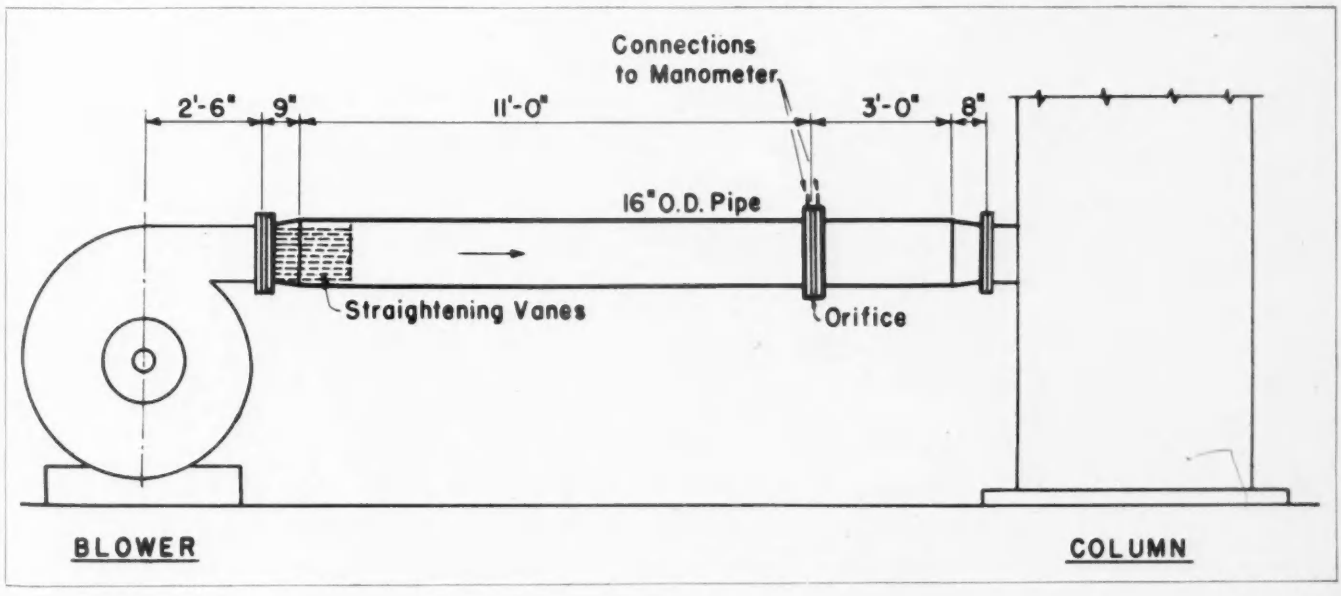


FIGURE 5. Arrangement of meter run at air blower.

lated and plotted. A simplified chart is here shown (Figure 2) comprising a small part of the complete working charts. Obviously tabulated data can be substituted for charts.

It will be remembered from Figure 1 that the change in K for high values of Re is very small and that for a limited range downward the change is also small. Hence, if only an average degree of over-all accuracy is required this value of S can often be accepted and used in the formula.

An example will further illustrate the procedure: Liquid ammonia is metered in a four-inch pipe run, using flange taps and an existing sharp-edge orifice plate of 2.190-inch diameter, and a recording secondary unit of maximum capacity of 50 inches of water.

$\beta = 0.5389$

At $Re = 150{,}000$, $S = 0.1844$

From the formula

$$q_1 = 0.0997\ S\ D_1^2 \sqrt{\frac{h_w}{\rho_1}}$$

the flow rate at $h_w = 50$ is found to be 154.9 gallons per minute.

Should, however, a higher degree of accuracy be required, or if the installation is outside the narmal range, Re can be calculated, based on the orifice diameter corresponding to 150,000, and a correction applied to the flow coefficient. This correction factor is a function of pipe diameter, orifice diameter and Reynolds number and can be easily plotted for each pipe size as shown on Figure 3.

In the example just referred to the actual value of Reynolds number is 640,000. The corresponding correction factor is 0.997, making the corrected flow rate 154.4 gpm, or a difference of 0.5 gpm. This proves the point that the correction can often be ignored.

Determination of Pipe Size

Before leaving the subject of computations an approximate method for determining the diameter of pipe for the orifice run will be outlined. The chart shown in Figure 4 gives the relationship between flow rate and standard pipe size for three cases. The line near the center corresponds to an arbitrarily chosen average case representing the optimum metering condition. The other two lines form the borders of a band within which all reliable installations should fall.

In designing the chart the density of water has been used. For the purpose of selecting a standard pipe size, however, the same chart can be used for liquids within a wide range of densities from, say, gasoline to liquids heavier than water.

The same type of chart can be used for metering steam or gas. In that case, another variable, corresponding to pressure, would have to be added.

Standard Orifice Sizes

In many plants there have been attempts at systematic standardization of orifice plates. The object has been to select a minimum number of standardized orifice sizes for each pipe size in general use. The number of plates and the size of the orifices are chosen such that any reasonable range of flow rates can be accommodated by a single standard orifice plate from stock. One disadvantage is that a so-called direct reading meter chart cannot be utilized. On the other hand, the direct reading chart is correct only for the calculated temperature, density, pressure, etc., and for accurate interpretation requires certain corrections. It can then be argued that this can just as easily be a major correction, which would in general be required when using standard orifices. A general acceptance of this standardization would not only simplify the maintenance problem in a large plant but also in all probability produce orifice plates of better workmanship.

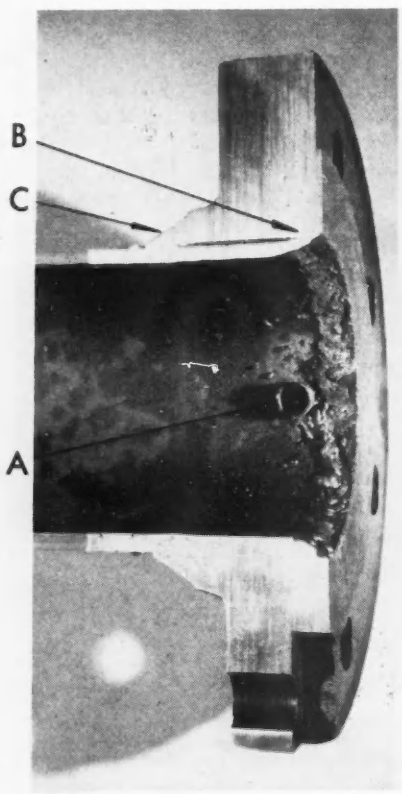
Tap Arrangements

There are four types of tap arrangements predominantly used for orifice installations. In the U. S. the flange taps, with the centerline of the tap one inch upstream and downstream of the face of the orifice plate, are used more than any other kind and this usage seems to be gaining. Pipe taps, which approximately measure the permanent pressure drop through the installation, are most commonly used by the gas industry. The other two, vena contracta taps and corner taps, are here probably used only for special installations. In the case of corner taps the pressure connections are slots between the pipe ends and the face of the orifice plate. It has been pointed out that this system possesses certain practical and theoretical advantages. It is universally used in Europe.

Without taking sides, it can be stated that in the majority of cases one of these systems could be accepted as the preferred standard, not excluding the others but limiting their use to special cases.

Accuracy and Errors

One subject that has been quite neglected in the published literature is that of accuracy and errors. A high degree of accuracy is not always required in metering, but it is essential to know



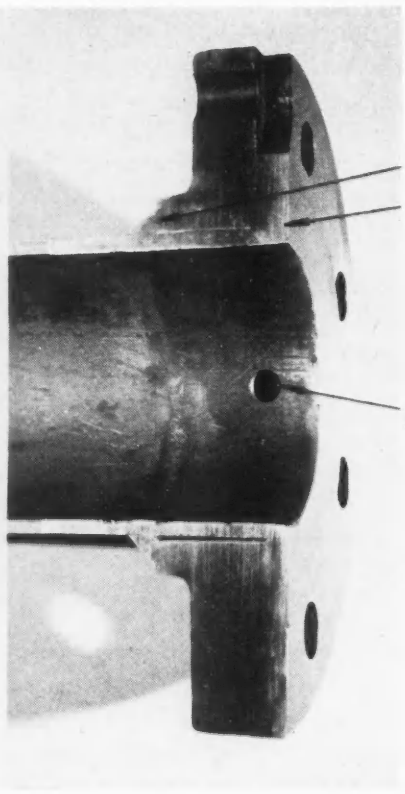
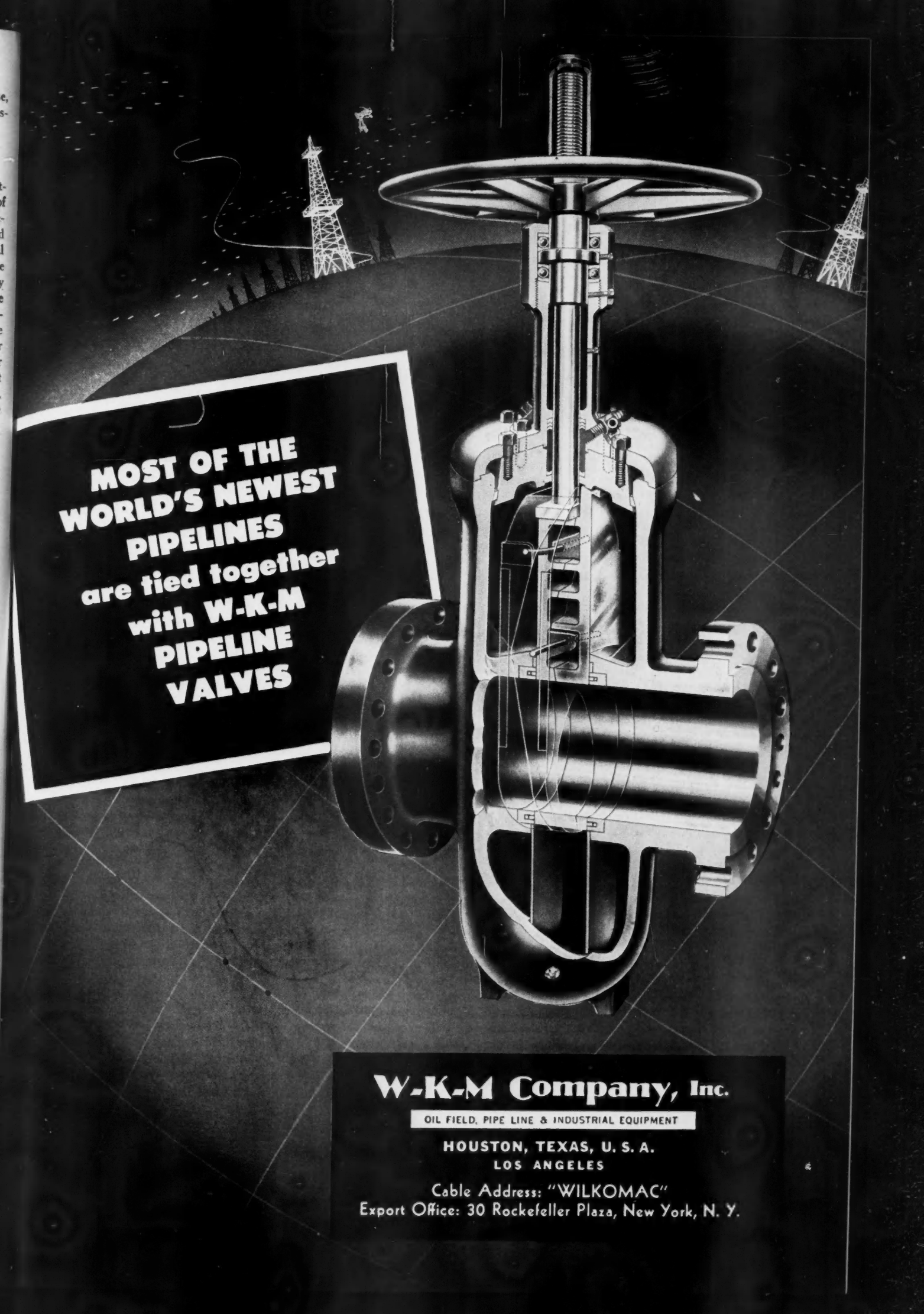


FIGURE 6-A (Left). Section of field-fabricated orifice assembly.

FIGURE 6-B (Right). Section of shop-fabricated orifice assembly.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when it is achieved and the degree of accuracy.

In some cases the sign of the error is known. A slight roundness of the upstream edge of the orifice, for instance, will increase the flow coefficient and hence the flow rate, so will also a decrease in the relative roughness of the pipe wall. There are other cases where the sign of the error is not obvious, it may be either plus or minus.

It is well known that certain fittings and other disturbances have a detrimental effect on the accuracy of flow metering. When such disturbances are present, a specified minimum straight length of pipe on both sides of the orifice is required, in order to dampen the turbulence. This requirement is quite often sinned against because, unfortunately, it is generally an expensive and cumbersome proposition, and for this reason at times even resisted by management. It seems possible to investigate and define the approximate errors for installations involving straight pipe length, shorter than the recommended minimum.

Blower Disturbance

As a curiosity it should be mentioned that such a serious disturbance to regular flow conditions as a blower or a centrifugal pump is not even mentioned in the tables or charts for required straight pipe adjacent to an orifice. A recent experience with an air blower may therefore be quoted. Figure 5 shows the arrangement. The static pressure was close to atmospheric, and the flow rate varied from 700 to 5000 cubic feet per minute. The orifice run had a diameter of 16 inches, and due to limited room the straight length upstream from the orifice was only 8½ times the diameter. As a guide for future installations an investigation was made to define the magnitude and the consistency of the errors, with and without straightening vanes. It was found that:

1. The relative deviation was consistent, and almost constant with varying flow rate, both with and without straightening vanes.

2. Without straightening vanes and for a diameter ratio, $\beta = 0.36$, the observed flow rate was 14 percent lower than the actual flow rate; at $\beta = 0.48$ the discrepancy increased to 17 percent and at $\beta = 0.62$ to 23 percent.

3. With straightening vanes, consisting of 36 two-inch outside diameter tubes, 20 inches long, the error was greatly reduced, with reversed sign. Thus, the observed flow rate was about 3 percent higher than the actual flow rate, regardless of orifice ratio.

4. Rapid pressure pulsations in the system were radically decreased in magnitude without introduction of straightening vanes. Even so it was felt that pulsations were responsible for at least a part of the remaining 3 percent error.

The figures will probably be different for even a slight variation of the arrangement, but even one set of experimental figures will help in planning similar future installations.

An ASME sub-committee has recently reported on tests with eccentric orifices. Full eccentricity was found to increase the flow coefficient by only about 3 percent, showing that—contrary to popular opinion—a slight eccentricity is quite unimportant to the accuracy of the installation.

There are indications that a great deal of data on this subject is hidden away in reports, not readily available, or in foreign publications. Notably the *Verein Deutsche Ingenieure* has more quantitative information on errors and tolerance than the American publications, but, due to difference in tap location and other specifications, some of it is not clearly applicable here and the rest is for the same reason under suspicion. It is therefore suggested that all existing errors and tolerances be correlated, complemented by further experimentation, and then published in a form that can be utilized by the practical engineer.

Installation

One more point seems worth mentioning. Strictly interpreted, it is outside the scope of this paper, as defined by the title. On the other hand, it is closely related to previously mentioned points. Anyone who has worked with orifice installations will have encountered the result of the overconscientious machinist. As a finishing touch he will lightly touch the sharp upstream edge of the orifice with a piece of emery cloth. Another time, a welder will apply a nice strong weld, between the pipe and the orifice flange, which projects inside the pipe. The result of improper field welding and other field work is more common and more obvious but all cases have this in common, they introduce unnecessary errors in the metering.

Figure 6-A shows an example of the bad features that can be encountered in a field installation. "a" shows burrs at the tap, "b" points to a set-back of the pipe end of more than one-half inch, and also an improperly made and ragged weld; "c" is a very heavy weld on the outside, which has resulted in deformation of the pipe section at this point.

Figure 6-B is by contrast a well made shop installation. The inside of the tap is slightly rounded; the end-weld on the outside of the pipe necessitates machining the flange face after welding, which also insures a 90-degree angle between flange and axis of pipe.

A solution that should go a long way in improving workmanship is to have complete orifice assemblies, including full length orifice runs, made up in qualified shops, thereby omitting or at least avoiding field fabrication. The cost may sometimes be slightly higher, but the accuracy of the metering should be materially improved.

Summary

Reviewing the sources of information available to the practical engineer it is concluded that a clear and simple presentation is lacking. Such a presentation should give the engineer a simple tool for designing an orifice installation, without sacrificing a grasp on the underlying principles, and without necessitating a thorough study of the whole subject.

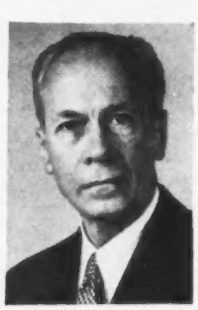
A new method for computing the orifice size and other related factors has been explained. Sample design charts have been presented, including a chart for selecting the pipe size of the orifice run. In this connection, the use of a flow coefficient, based on pipe size in preference to the orifice size is advocated.

It is also concluded that the work of standardization has only begun and should be pursued further, and that the subject of accuracy and errors in metering is meager in information, applicable to practical installations.

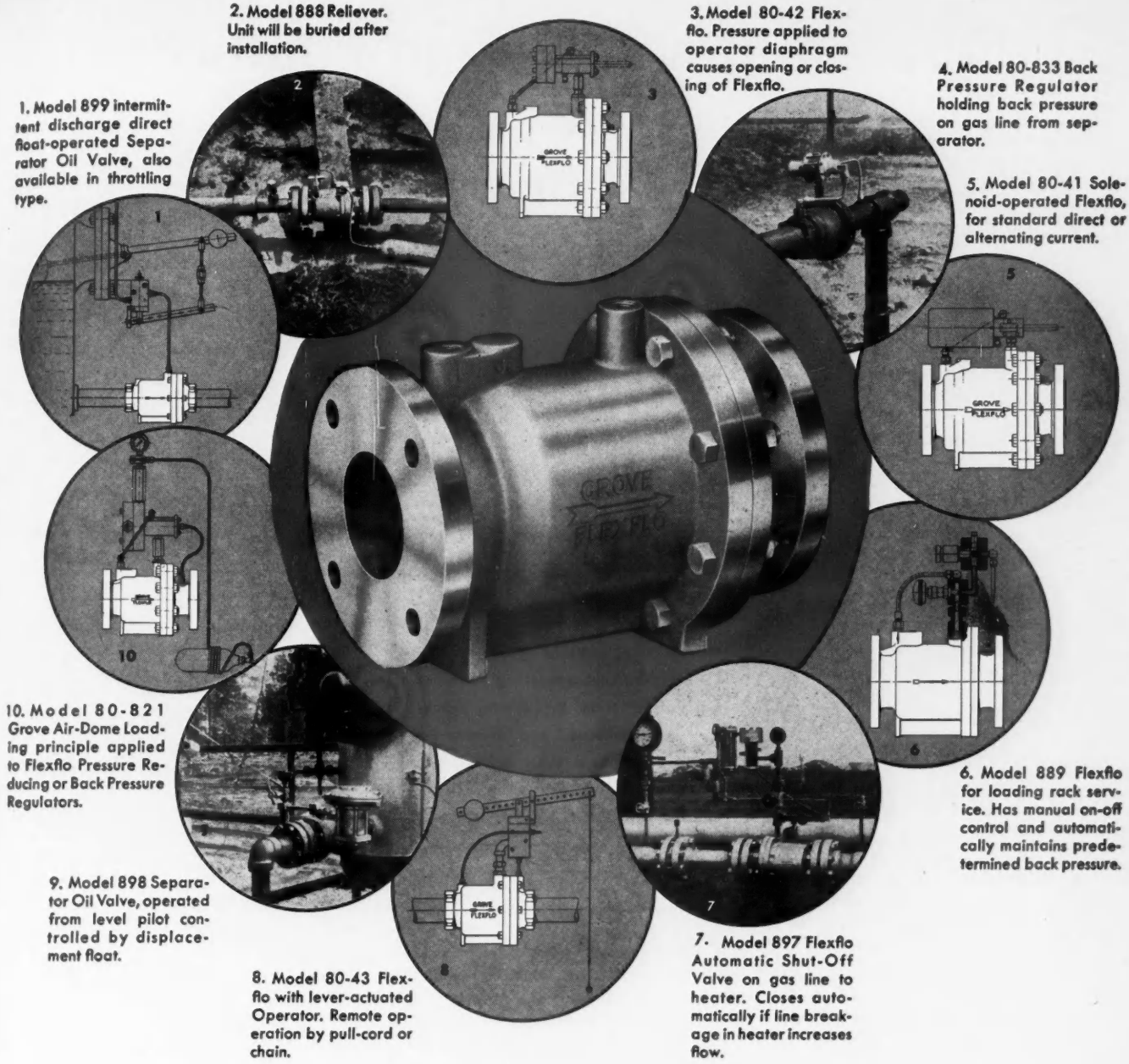
ACKNOWLEDGMENTS

The author is indebted to M. V. Long and E. B. Wist, Shell Development Company, and L. K. Spink, member of the AGA-ASME Joint Committee, for helpful suggestions and information in preparing this paper.

About the Author



HERMAN A. JACOBSON was graduated from the Royal Institute of Technology, Stockholm, Sweden, with the degree of Civil Engineer. He practiced civil and structural engineering in Sweden and Dutch East India until 1924, when he came to the U. S. He has been connected with Shell Chemical Corporation and Shell Development Company for 19 years, first on plant design and construction and later on mechanical research problems, with emphasis on fluid flow research.



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Operating and Design Features of *Adsorption-Type Dehydrators*

By MAX L. RILEY

Southwest Gas Producing Company, Inc.

THE AUTHOR outlines the regenerative and normal operating cycles of adsorptive units for drying mainline gas streams, and shows, by examples, how such dehydrators are designed and selected for specific installations. A series of moisture-content curves for saturated gas simplifies computations.

ADSORPTION processes to remove water vapor from gases have been in use for many years, but application to high pressure systems is rather recent. Especially is this true with high pressure gas transmission, and gasoline extraction plants.

Because adsorption is a surface phenomenon, the water or other adsorbed substance remain concentrated on the surface of the desiccant and do not reduce the adsorbent to a solution as would be expected with certain adsorbents such as calcium chloride. It is therefore subject to repeated use by regeneration, with only a slight reduction of its adsorptive efficiency.

From the standpoint of a unit process, it is simple in operation, requiring but few facilities outside of the desiccant towers, and because the adsorbent remains as a solid, process pumps are eliminated by the natural flow of the gas performing the regenerative cycling.

The application of this process has permitted gas transmission companies to reach optimum line pressures without the attendant formation of gas hydrates, which in turn has permitted the transportation of natural gas to any section of the country regardless of ground temperatures encountered.

Its application is gaining importance to high pressure gasoline plants[1] in that moisture removal from the condensate gas allows over-all economics in the gasoline extraction process through low temperature adsorption. In such dehydration practices, the residue gas needs no further drying and is readily salable at dew points below maximum allowances.

As previously mentioned, the operation of adsorptive-type driers is relatively simple. The stream of moisture saturated gas is passed over a bed or series of beds of the solid desiccant where the water is removed at near 100 percent efficiency. When the adsorption capacity of the beds is reached, the efficiency declines rapidly, until ultimately the outlet stream of gas may show the same dew point as that entering the vessel. In practice, however, the tower is switched from drying to regeneration either on a definite time cycle, or when the outlet gas shows an appreciable increase in dew point. Since the aluminum oxide type desiccants (activated alumina,

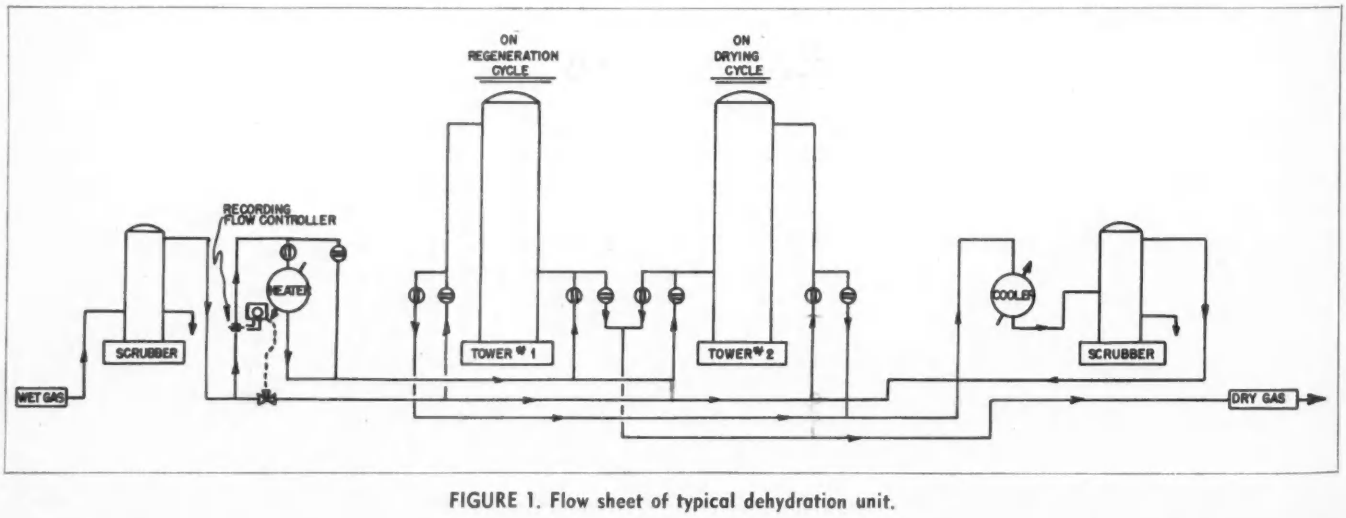

FIGURE 1. Flow sheet of typical dehydration unit.

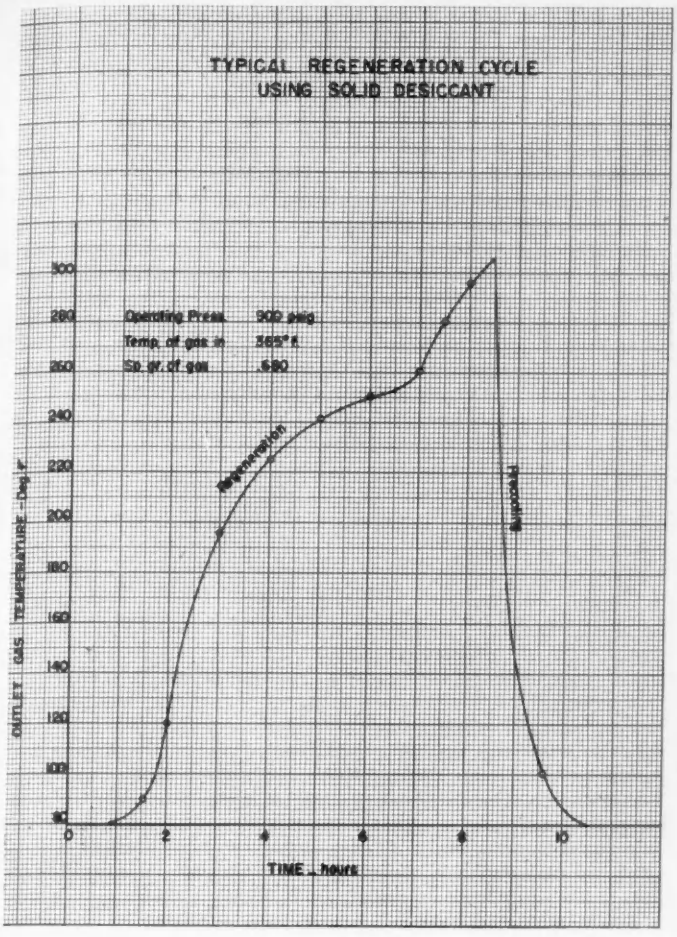

FIGURE 2

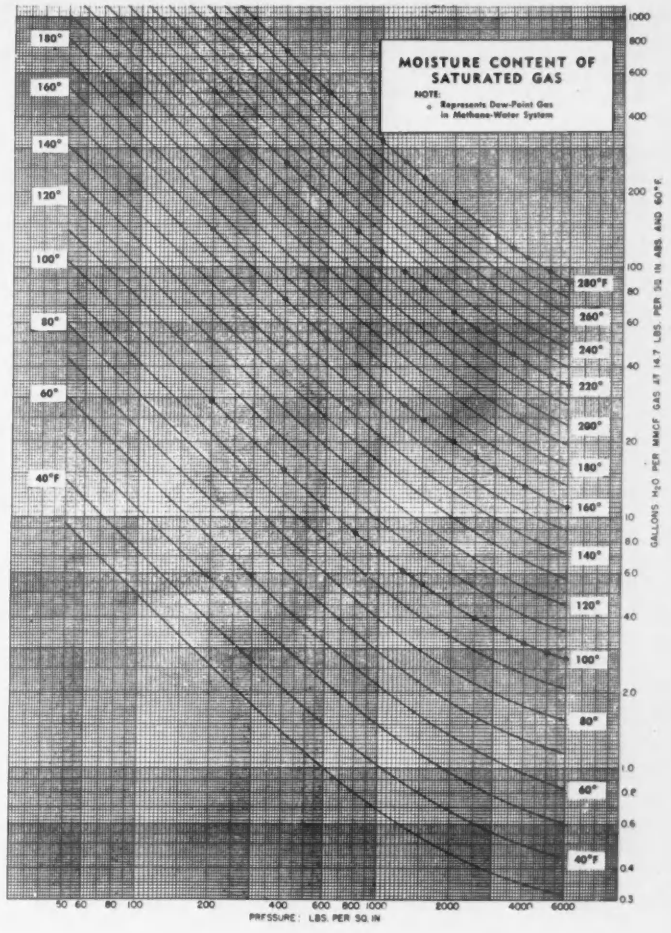
MOISTURE CONTENT OF SATURATED GAS
NOTE:
Represents Dew-Point Gas in Methane-Water System
PRESSURE - LBS. PER SQ. IN
GALLONS H2O PER MMCF GAS AT 14.7 LBS. PER SQ IN ABS. AND 60°F

FIGURE 3

and activated bauxite) reduce the outlet gas dew points to zero and lower temperatures, a rise to plus 5-10° F. is usually considered as time for regeneration.

Typical System

A typical dehydration system is shown in Figure 1. The stream of wet gas flows downward through the tower where, by intimate contact with the desiccant, the moisture is removed. The dry gas then passes from the bottom of the vessel into the gathering system.

Regeneration is accomplished by passing hot gas at temperatures from 350-400° F. through the wet tower, thus removing the adsorbed water along with the highly undersaturated hot gas. The regenerated gas is taken off as a side stream just ahead of a pressure reducing regulator. A recording flow controller positions the valve automatically thereby forcing the required amount of gas through the heater, desiccant tower, exchanger (or cooler), gas-water separator, and then into the wet gas stream to the dehydrator. This, of course, imposes an additional load on the desiccant. However, since the regeneration gas stream represents such a small portion of the total stream, the resultant overload is of only relative importance. However, it is all the more reason why this stream should be held to a minimum. A typical regeneration cycle is shown in Figure 2.

If the installation is in an area where water is not conveniently available, the water vapor contained in the regeneration gas may be condensed by flowing this stream through an exchanger. The exchange would be between the dry gas leaving the tower and the hot regeneration gas. Though the temperature of the latter may be near 300° F., it represents only about 10 percent of the total stream, so that the resultant temperature rise of the dry gas stream will seldom exceed 20° F.

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The regenerated tower is then ready for pre-cooling, before being switched to a drying cycle. This is a very important phase of the process. Without pre-cooling (which is simply using the same regenerative gas stream except the heater is bypassed), the velocity of the hot expanded gases would be increased about 50 percent above normal as the main gas stream was turned into the tower. It would be only momentary, but it is sufficient to cause abrasive action of the desiccant grains which produce dust-like particles (fines). Also, without pre-cooling, unnecessary thermal shock is imposed on valves, fittings and lines leading from the vessel.

Adsorption Efficiency

In planning the installation of the adsorptive-type unit, it is important that provisions be made to have some control over maximum temperatures of the wet gas stream to the unit. Pressure (at least to 1200 pounds) seems to have no effect on the adsorption efficiency,[2] but temperature affects it to a very great extent. Table 1 shows the relationship between the wet gas temperature and adsorption capacity (as reported on activated bauxite by an equipment manufacturer) of the desiccant in terms of its percent by weight of water.

It is quite obvious, from this and Figure 3, that the most desirable operating condition would be at a maximum pressure and a minimum temperature. The available working pressures, and economics involved in high pressure facilities would determine the maximum pressure, and expected hydrate formation point would limit the minimum temperature.

Also at temperatures of around 80° F., an appreciable quantity of hydrocarbons is adsorbed and condensed along with the water from the regenerative gas. Table 2 shows the analysis of this liquid taken from the gas-water separator. In this case, a gas at 900 pounds per square inch gauge and 80° F., containing 1.000 gallons per minute of propane plus fractions, was being dried through towers. The sample was taken near the end of the regenerative cycle when the top (outlet) temperature of the contactor was 262° F. This system is part of a gasoline extraction plant process and the liquid is processed along with the gas-condensate. Unfortunately, the quantity was not determined at the time the sample was taken, but since it would be expected to vary with the richness of the gas being dried, and the operating temperatures, it is of only relative importance.

Designs of the desiccant towers incorporate different features among the various manufacturers, but in general they hold as outstanding the basic principles of pressure drop through the beds, desiccant quantity and accessibility to the desiccant for replacement.

Though it has been the usual practice to use vertical vessels, a recent installation has horizontal vessels. The gas enters the bottom and flows upward through the bed with a very low resultant velocity and pressure differential. Excellent performance has been reported.

It has been proposed[2] that allowable gas velocities through the packed tower is in the range of 20-60 feet per minute based on the cross-sectional area when empty. It would be difficult to make a generalized statement as to the maximum allowable velocity because of the influence of granular size, design of tower, and distribution of the gas flow through the tower. However, operating experiences indicate that velocities through 4-8 mesh desiccant of 25-40 feet per minute (based on empty tower) will not cause harmful pressure differentials, and will afford sufficient contact time to permit good adsorption efficiency.

The quantity of desiccant required is determined by its adsorption capacity. Where activated bauxite (Florite) is used, it is general practice to use five percent as the capacity. For example, the complete adsorption of 100 pounds of water would require $(100 \div .05) = 2000$ pounds of activated bauxite. This allows a reasonable safety factor for temperature variations in the gas stream as indicated by Table 1.

Though, obviously, the greater number of cycles per day will decrease the amount of desiccant per tower, the saving in this respect is rather small, because the percent of the installation cost chargeable to desiccant is probably less than 5 percent. Regardless of the number or time of the cycles per day, the diameter must still be large enough to pass the full stream of gas. Therefore, the cycles per day, insofar as the tower is concerned, will in effect determine only its height. Increasing the number of cycles decreases the required desiccant, thereby decreasing the height of the bed for a given diameter. However, this arrangement has its limits: The minimum time required for regeneration and pre-cooling will limit the cycle period. This can be accomplished in six hours or less, but it would be most impractical to have the units sized for such a cycle. First of all, the cycle should be long enough to allow sufficient time for removing and replacing the desiccant in the alternate tower. This will usually require eight to 12 hours, depending upon the size units and the accessibility to the bed.

The following is an example calculation applying the aforementioned design features:

Example

Assume that a small condensate gas structure has been developed which has an expected maximum efficiency recovery of 20,000 mcf per day. It is decided to produce the reserve by depletion, but due to the daily quantity of gas available, a fully integrated processing plant that would extract a high yield is not feasible, even though a recovery of 50 liquid per million cubic feet of gas is expected. However, 25 miles distant is such a plant with these facilities and having a capacity to process this additional amount of gas. Also, this plant is connected to one of the larger natural gas transmission lines, thereby affording sale of the residue gas.

The possibilities are investigated and it is found to be economical to transport the condensate gas over this distance. Also, to eliminate hydrate difficulties in transmission, it is decided to separate the free water at a central station in the field, and remove the remaining moisture by dehydration.

TABLE 1

Gas Temp. °F.	Adsorption Capacity Percent by Weight
60 Degrees	7.35
65	6.67
70	6.00
80	5.00
90	4.00
100	3.00
120	1.90
140	1.10

TABLE 2

Analysis of Liquid Hydrocarbon from Regenerative Gas-Water Accumulator

	Mol. Percent
Methane	10.70
Ethane	7.96
Propane	7.29
I Butane	2.54
N Butane	5.68
I Pentane	4.46
N Pentane	3.95
Hexanes plus	57.42

Conditions:

Required Input Pressure	1500# psi
Separator Temp.	80° F.
Moisture in saturated gas (Fig. 3)	2.95 gals./MMCF

A. Desiccant Required

$$\frac{2.95 \times 8.33 \times 20}{.05} = 9830 \text{ lbs.}$$

At 50 lbs./cu. ft. = 196.6 cu. ft.

For each Tower on an 8-hr. cycle:

$.333 \times 9830 = 3275$ lbs.

$= 65.5$ cu. ft.

B. Tower Size

Assume an allowable velocity of 25 ft/min. based on the cross-sectional area with desiccant removed. Also this is a .700 Sp. Gr. gas. The supercompressibility factor is computed to be .760 at 1500# at 80° F.

$$A. = \frac{Q}{V}$$

$Q = 20{,}000$ Std. MCF/day $= 13{,}889$ std. cu. ft./min.

At 1500# and 80°

$$Q = \frac{13{,}889 \times 15 \times 540 \times .760}{1500 \times 520} = 109.6 \text{ cu. ft./min.}$$

$A = 109.6 \div 25 = 4.38$ sq. ft.

$$d = \frac{(4.38)^{1/2}}{(.785)} = 2.36 \text{ ft.}$$

C. Height of Desiccant Bed

$2.36 \times 2.36 \times .785 \times L = 65.5$

$L = 15$ ft.

Height-Diameter Ratio $= 6.35$

Note: Increasing the tower diameter to next standard size would make the height-diameter ratio fall within the desired range.

REFERENCES

[1] Ambrose, Z. C., "More Propane for Less Money," Oil & Gas Journal, March 25, 1948, Page 127.

[2] Amero, R. C., Moore, J. W., Capell, R. D., "Design and Use of Adsorptive Drying Unit," Chemical Engineering Progress, July 1947, Page 349.

BIBLIOGRAPHY

Deaton, W. M., Frost, E. M., Jr., "Gas Hydrates and Their Relation to the Operation of Natural Gas Pipe Lines."

"Activated Alumina, its Properties and Uses," Publication by Aluminum Ore Co.

Deaton, W. M., Frost, E. M. Jr., Bureau of Mines Apparatus for Determining the Dew Point of Gases under Pressures, Bureau of Mines Rept. of Investigations 3399, 1938, Page 4.

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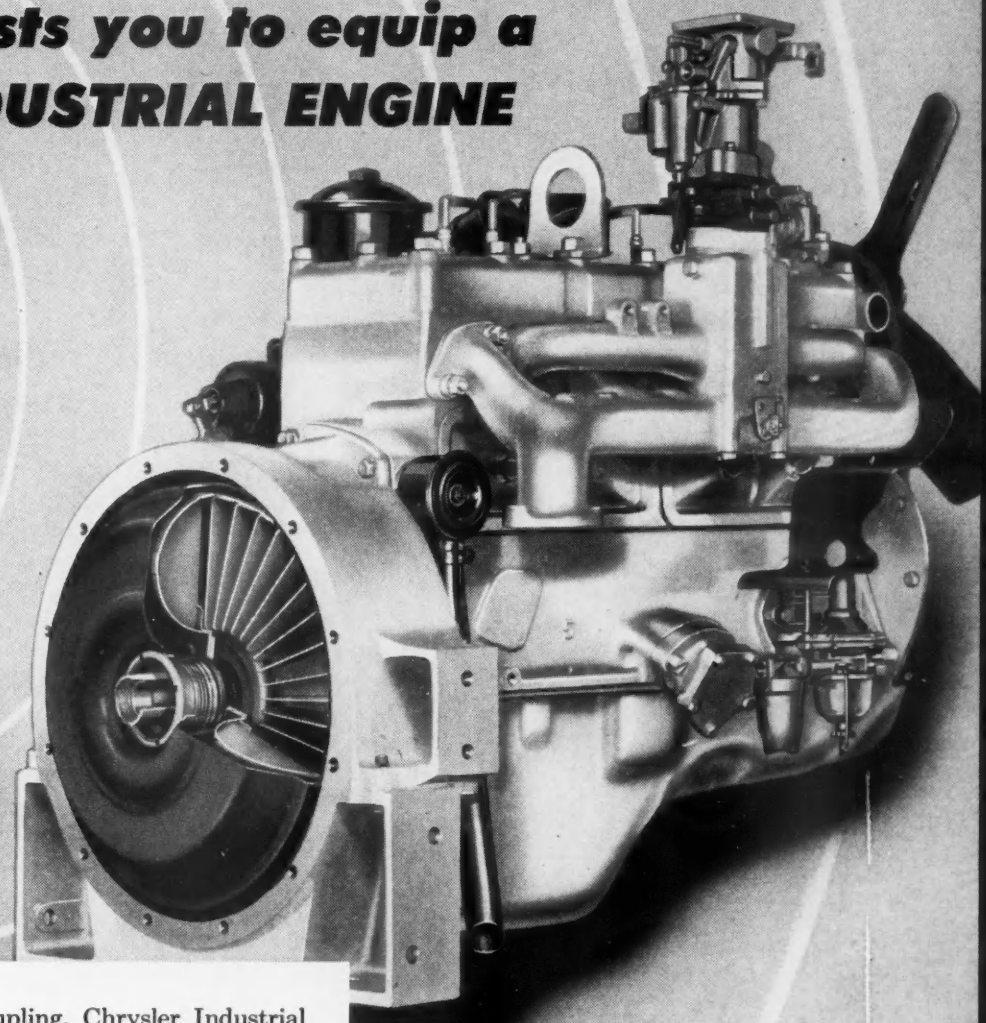

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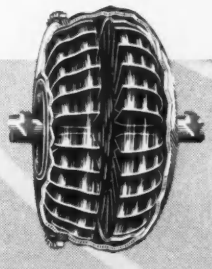

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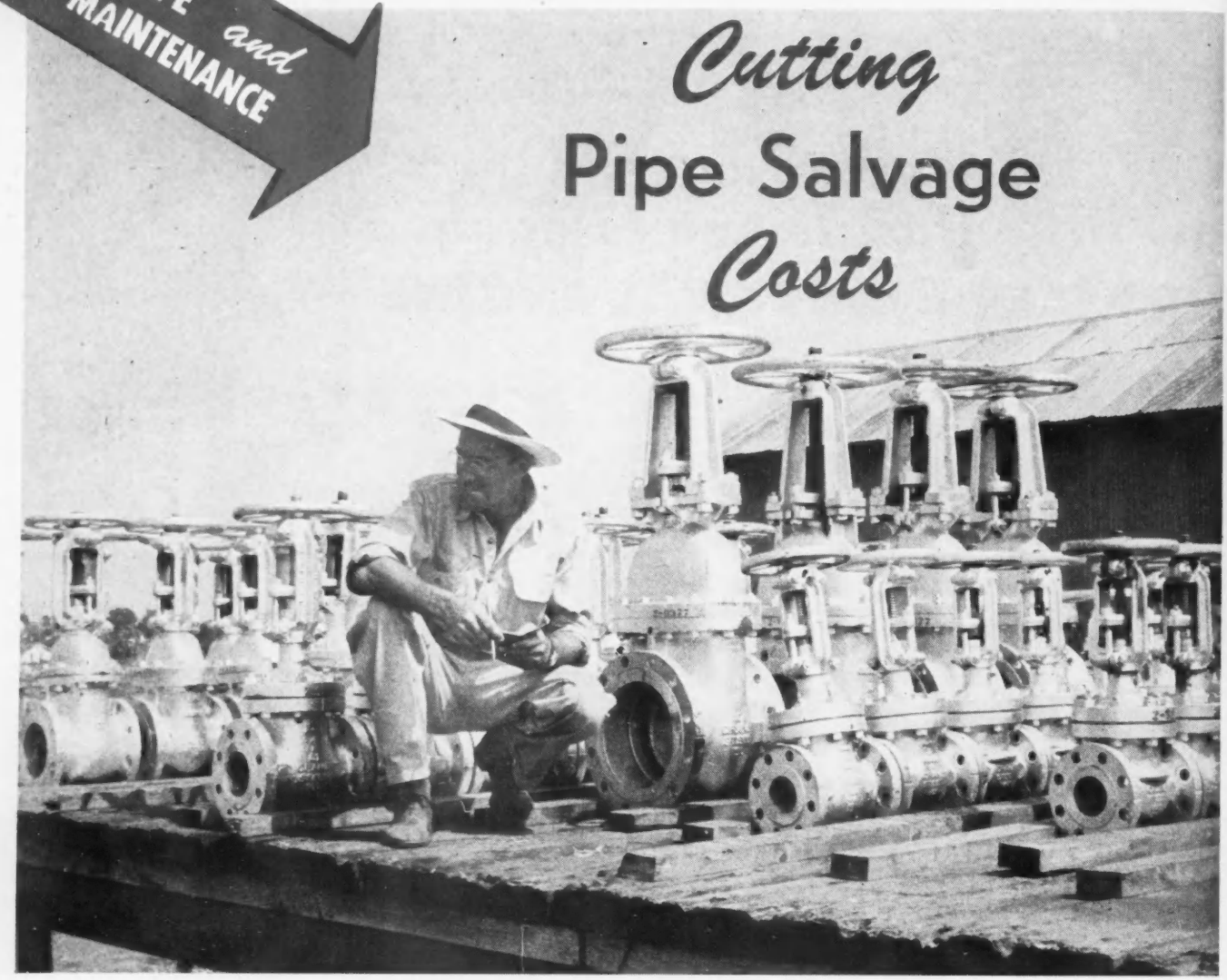
CARE and MAINTENANCE

Cutting Pipe Salvage Costs



Parts numbers being checked on an assortment of repaired gate valves.

IMPROVED production methods in salvaging pipe at Phillips Petroleum Company's Oklahoma City warehouse and salvage yard have cut costs in half during the past seven years. At that time company pipe reconditioning costs averaged ½ cent per inch diameter per running foot to recondition used pipe either inside or out. Today, the work is being done for only ¼ cent per inch diameter per foot. This represents a very substantial saving since the company processed more than 1,200,000 feet of pipe ranging from 2-inch to 24-inch during 1948 alone.

W. D. Petre at the Phillips Oklahoma City salvage yard revealed some of the "wrinkles" and short cuts which Phillips employees are using and which other oil companies might apply in order to cut down their pipe salvaging bill.[1]

For example, it usually was necessary in the past to move pipe three or four times with truck gin poles to complete the reconditioning process. With the new assembly line method pipe can be straightened, cleaned inside and out, beveled and welded into double random lengths in one continuous operation. Instead of pipe being carried by truck or manpower from one operation to another, it is now moved by rollers and other labor-saving devices constructed by salvage yard employes.

A high-pressure steam hose is used for internal pipe cleaning, but the hose is now suspended from a welded steel tower. This suspension eliminates wear that the hose previously received by continually dragging on the ground. A power-driven carriage, traveling on rails, pushes a pipe scraper and cleaner through the pipe. In the same operation steam jet pressure from the suspended steam hose forces loosened scale and rust into a waste pit.

All operations of the cleaning mechanism are controlled from a panel board placed in such a manner that the operator is always a safe distance from moving machinery.

Reconditioning pipe is only one of the many jobs performed at Phillips' warehouse salvage yard and shop. Used gate valves of all sizes are received from various operations in Kansas and Oklahoma for repair.

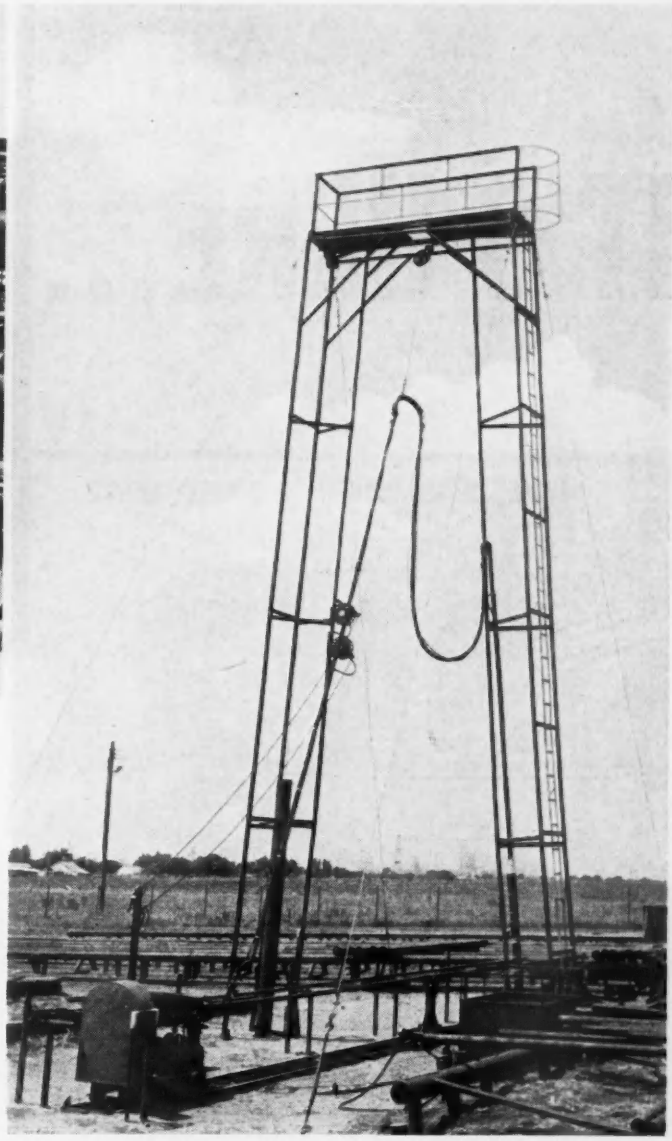
Receiving, repairing and issuing materials with maximum efficiency are major factors in any successful cost control program. But such a program is possible only when employes are cost-conscious and constantly alert to find faster and safer methods of doing these jobs.

Phillips employes are responsible for improved techniques and savings which have been reported. Economy-minded, they are devising new equipment and using new methods to reduce costs of operations.

REFERENCE

[1] *Philnews*, Sept. 1949.

ABOVE: Used gate valves, in for repairs, are conveniently racked on salvage shop dock according to size.

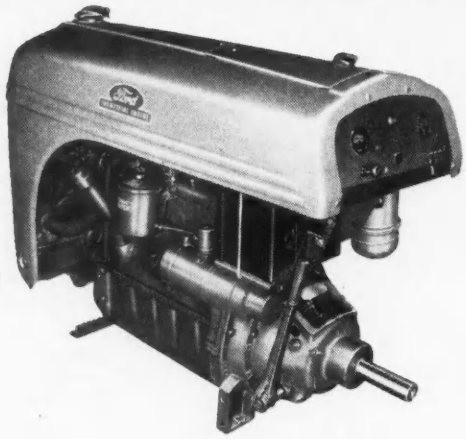


RIGHT: The steel tower at the Phillips Oklahoma City warehouse salvage yard is designed to keep high-pressure steam pipe and hose from dragging on the ground.

BELOW: Beveled two-inch pipe is readied for threading machine. Hydraulic lift is built on a swivel that eliminates need of employee having to lift and turn pipe.

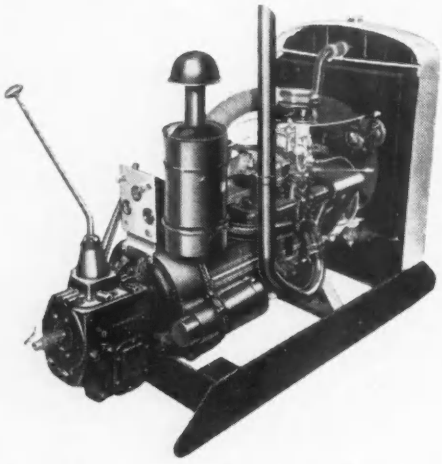
IT'S HERE...

NEW Ford "120" POWER UNIT



Removable dry cylinder liners . . . 3-ring pistons, chrome top ring . . . Moly-chrome valve seat inserts . . . Circulating cooling system with thermostat . . . Replaceable thin shell main and connecting rod bearings . . . Counterbalanced crankshaft . . . Magneto or battery ignition . . . Oil filter . . . Heavy duty oil bath air cleaner.

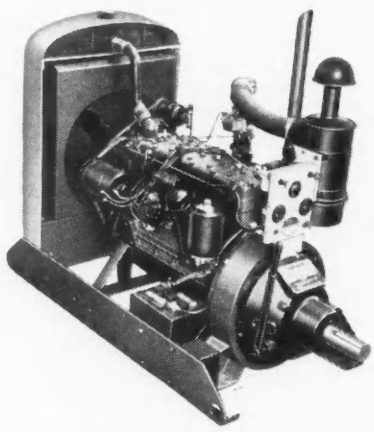
NEW Ford "226" POWER UNIT



Pad mounted oil filter . . . Full length water jacketing . . . Recirculating pressure cooling system with thermostat . . . Counterbalanced crankshaft . . . Heavy duty, replaceable thin shell copper lead bearings . . . High lift camshaft . . . Balanced carburetion (downdraft or updraft) . . . Heavy duty oil bath air cleaner.

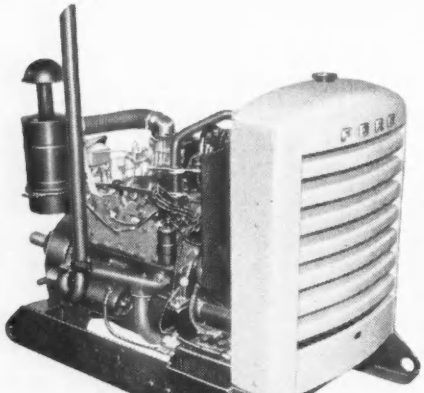
Complete

NEW Ford "254" POWER UNIT



Pad mounted oil filter . . . Recirculating pressure cooling system with thermostat . . . Autothermic pistons with chrome top compression ring . . . High lift camshaft . . . Hard faced cobalt exhaust valve (free type valves) . . . Counterbalanced crankshaft . . . Heavy duty, replaceable thin shell copper lead bearings . . . Balanced carburetion (downdraft or updraft) . . . Air cleaner.

NEW Ford "239" POWER UNIT



Dual water pumps . . . Full length water jacketing *plus* . . . Recirculating pressure cooling system with thermostat . . . Fully counterbalanced crankshaft . . . Replaceable thin shell bearings . . . Moly-chrome valve seat inserts . . . Dual downdraft carburetion . . . Oil filter and air cleaner.

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PIPE LINE *Construction*

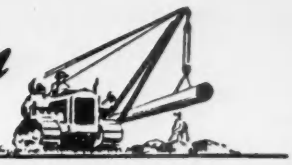

Table includes projects planned, contracts awarded, and spreads or entire projects completed since the last issue of WORLD OIL

COMPANY	Origin and Terminus	Length, (Miles)	Pipe Size, (Inches)	Daily Capacity (Barrels, Cu. Ft.)	REMARKS
CRUDE OIL LINES					
Atlantic Pipe Line Company	Block 31 fld., Crane Co., W. Texas to Refugio, S.W. Texas	382	10	35,000	Completed in Dec. by Evans & James Constr. Co., Little Rock, who sub-contracted from A. C. Holder Constr. Co., Tulsa.
	Refugio to Harbor Island, Texas	30	10	35,000	Shanks & Eustace, Alice, Tex., sub-contracted this job from Evans & James Constr. Co. and completed in Dec.
Gulf Refining Company	Heidelberg-Eucutta Dist., Jasper Co., Miss. to Mobile, Ala.	200	16	.....	This line being planned and would go via Baxterville fld.
Humble Pipe Line Company	Kemper, Reagan Co., W. Tex. to Satsuma, Gulf Coast	373	18	95,000	Morrison Constr. Co., Inc., Austin, will lay 178 miles, Kemper to Eckert. Anderson Bros. Corp., Houston, to build 195 miles, Eckert to Satsuma.
Montreal Pipe Line Company	Canadian border at N. Troy, Vt. to Montreal, Canada	70	18	.....	Canadian section of Portland to Montreal line. Fred Mannix & Co., Ltd., Calgary, will construct this Sect. 3.
Portland Pipe Line Corporation	So. Portland, Me., to Canadian border, at N. Troy, Vt.	166	18	.....	U. S. section of Portland to Montreal line. Canadian part to be built by Montreal P. L. Co., listed above. Oklahoma Constr. Co., Inc., Dallas, to build 85-mile Sect. 1. Associated P. L. Contractors, Inc., Houston, has contract for 81-mile Sect. 2.
Shell Pipe Line Corporation	McCamey to Kemper, W. Texas	40	10	40,000	Line being planned.
	Elk City fld., Beckham Co., to Basin System, Cushing, Okla.	160	10	24,000	Job including 190-mile 10-inch takeup, Cushing to Springfield, Mo., completed in Dec. by Trojan Constr. Co., Inc., Oklahoma City.
Socony-Vacuum Oil Company, Inc.	S. Cole Creek fld., Converse Co. to connection with existing 4-inch line in Natrona Co., Wyoming	7	4	.....	Completed by C. P. Bartley & Son, Lance Creek, Wyo.
Sohio Petroleum Company	W. Edmond fld., Okla., gathering system	10	4 to 8	.....	Work began in Nov. by Western State Constr. Co., Inc., Oklahoma City.
Stanolind Pipe Line Company	Knowles fld., Lea Co., N. Mex. to Jones Rch. Sta., Gaines Co., West Texas	9 7/10	4 & 6	.....	Completed by C. L. Rogers Constr. Co., Wichita Falls.
PRODUCT LINES					
Frontier Refining Company	Cheyenne, Wyo. to Omaha, Nebraska	300	.....	.....	Pacific P. L. & Engineers, Ltd., San Francisco, are making engineering study of this proposed project.
Great Lakes Pipe Line Company	Des Moines to Williams, Iowa	64 6/10	12	.....	O. R. Burden Constr. Corp., Tulsa, started in November.
	Williams to Minn. state line	72 3/10	12	.....	A. C. Holder Constr. Co., Tulsa, began Dec. 1.
	Minn. state line to St. Paul, Minn.	103 4/10	12	.....	Sheehan P. L. Constr. Co., Tulsa, started last half Dec. 1.
	St. Paul to Minneapolis	19 5/10	12	.....	Williams Bros. Corp., Tulsa, completed in Dec.
Phillips Petroleum Company	Loops in vicinity of Ottawa & Olathe, Kansas	18	8	.....	Vaughn & Taylor Constr. Co., Inc., Wichita Falls, has job in progress.
Salt Lake Pipe Line Company	Salt Lake City to Boise, Idaho	320	8	.....	Completed in Dec. Smith Constr. Corp., Ft. Worth, laid 169 mi., Salt Lake to Burley, Idaho. Okla. Contr. Co. & Grafe-Callahan Constr. Co., Los Angeles, built 151 mi., Burley to Boise.
Standard Oil Company (Ohio)	Toledo to Fostoria, Ohio	38	8	.....	Britton Constr. Co., Hamilton, Ohio, completed in Dec.
Trans-Northern Pipeline Company	Montreal to Toronto, Canada, via Ottawa	330	10	.....	Company owned by Imperial Oil, British-American & McColl-Frontenac. May be started by end of 1949.
NATURAL GAS LINES					
Arkansas-Louisiana Gas Company	Magnolia to Malvern, Arkansas	90 3/10	20	140 mln.	Latex Constr. Co. completed Dec. 15.
Atlantic Seaboard Corp. & Virginia Gas Transmission Company	Clendenin, W. Va. to Rockville, Maryland	268	26	.....	Now complete. Ray L. Smith & Son, Inc., El Dorado, Kans., built 68 mi., Clendenin to Cleveland, W. Va. H. C. Price Co., Bartlesville, laid 200 mi., Cleveland to Rockville. Excellent time was made and line completed ahead of schedule.
Central Hudson Gas & Electric Corporation	Tuxedo to Poughkeepsie, New York	40	.....	.....	FPC authorization received. Scheduled for Aug. 1950.
Central Kentucky Natural Gas Company	Menifee to Mt. Sterling, Kentucky, Loop	23	12	.....	Completed in Nov. by Williams-Austin Co., Pittsburgh.
Cities Service Gas Company	Vicinity W. Edmond fld., Oklahoma	23	10 & 12	.....	Gragg Constr. Co., Britton, Okla., started Dec. 1.
	Wichita-Newton, Kansas area	42 9/10	.....	.....	Application made to FPC.
Coast Counties Gas & Electric Company	Watsonville to Gilroy, California	10	10	.....	M. G. M. Constr. Co., Concord, Cal., began in Nov.
Eastern Natural Gas Corporation	Phoenixville, Pa. to Boston, Mass	292	24	200 mln.	Permission to build this system has been asked of FPC.
	Sales laterals along route	200	.....	.....	
East Tennessee Natural Gas Company	Co.'s line near Oak Ridge to Co.'s proposed line near Knoxville, Tennessee	18	.....	.....	FPC authority granted.
Michigan-Wisconsin Pipe Line Company	Milwaukee to Fond du Lac, Sheyboygan & Green Bay	196	.....	.....	G. G. Griffis Constr. Co., Tulsa, started a lake crossing in Dec. Main work to start in Spring, 1950.
Mississippi River Fuel Corporation	Near East St. Louis, Illinois	9½	20 & 24	.....	Completed Dec. 20 by Sheehan P. L. Constr. Co.
Montana-Dakota Utilities Co. & Montana-Wyoming Gas Pipe Line Company	Worland fld., Wyo. to Cabin Creek Sta., Montana	340	12	35 mln.	FPC certificate granted.
The Montana Power Company	Butte to Bozeman, Montana	83	12	.....	Contract not let. To start in Spring, 1950.

Table includes projects planned, contracts awarded, and spreads or entire projects completed since the last issue of WORLD OIL (CONTINUED)

COMPANY	Origin and Terminus	Length, (Miles)	Pipe Size, (Inches)	Daily Capacity (Barrels, Cu. Ft.)	REMARKS
Northern Natural Gas Company	Okla.-Kans. state line to Sublette, Kansas	23¾	20 & 24	.....	R. H. Fulton & Co., Lubbock, Tex., awarded contract which includes 2500-ft. 20-inch Cimarron River crossing. To start Jan. 2.
The Ohio Fuel Gas Company	TETCO "Inch" lines to Crawford Sta., Sugar Grove, Ohio	10⁹⁄₁₀	16	.....	Completed in Dec. by Mahoney Contr. Co., Mt. Pleasant, Michigan.
Oklahoma Natural Gas Company	Stillwater to Guthrie, Oklahoma	22	10	.....	Started Dec. 15 by Trojan Constr. Co., Inc.
Roanoke Pipe Line Company	Va. Gas Trans. line at Gale to Roanoke, Va.	30	.....	.....	Application made to FPC.
Tennessee Gas Transmission Company	Lancaster to Winchester, Ky. loop	33	30	.....	These two sections completed in Dec. by Anderson Bros. Corporation.
	Winchester to Morehead, Ky. loop	44	26	.....	
	Near Eagle Lake to near Columbus, Texas, Gulf Coast	21	12	.....	Massey Pipe Line Constr. Co., Corpus Christi, completed in December.
	Near Bay City to near Lissie, Texas Gulf Coast	42	8 & 16	.....	Completed in Dec. by Sheppard-Geiger Constr. Co., Corpus Christi.
	Miss.-Tenn. state line to Selmer, Tenn. loop	17	30	.....	H. C. Price Co. completed in December.
Texas Eastern Transmission Corporation	Lebanon, Ohio to Connellsville, Penna., loop	255	30	.....	Amendment of old application to FPC. Plan would install additional 49,200 hp. on "Inch" lines which would up system capacity to 940 mln. a day.
	Lambertville, N. J. to Boston, Mass.	255	26	200 mln.	
	Laterals in Conn., R. I., Mass., & N. Hampshire	292	.....	.....	
Texas Gas Transmission Corporation	Green River, Kentucky, crossing	.....	20	.....	Midwestern Constructors, Inc., Tulsa, completed Nov. 30.
Texas Illinois Natural Gas Pipeline Company	Texas Gulf Coast to Joliet, Illinois	1254	26 & 30	300 mln.	Original application amended Dec. 9. New plan would cost about $168 million and would be scheduled to start Oct., 1950 and to complete Nov. 15, 1951. If and when the Piedmont lateral should be built, the main line capacity would be increased to 585 mln. a day.
	Proposed Tex.-Ill. line at Little Rock to Piedmont's proposed Tex.-Va. line near Greenville, Miss., lateral	20	26	285 mln.	
	Joliet to Nat. Gas. P. L. Co.'s line at Volo, Ill.	58	20	.....	
Transcontinental Gas Pipe Line Corporation	Bassfield, Miss. to Tombigee River, Alabama	112	30	340 mln.	Section of Texas-New York line. Completed in Dec. by Wunderlich & Griffis Constr. Co. Tulsa.
United Fuel Gas Company	TGT's line to storage flds. near Nitro & Clendenin, W. Va.	12	10 & 20	.....	Application made to FPC.
United Gas Pipe Line Company	Carthage-Sterlington (La.) line loop	105⁹⁄₁₀	20	.....	O. C. Whitaker Co., Ft. Worth, started in November.
	Miss. River Delta flds. to New Orleans	90	16	100 mln.	$11 million project planned late in 1949.
	Flds. in DeWitt & Goliad counties to United's Refugio to San Antonio, Texas, line	12	16	100 mln.	This line will provide first major outlet for 13 gas producing flds. Brown & Root, Inc., Houston has contract.
	Gathering systems in above fields	34	.....	.....	

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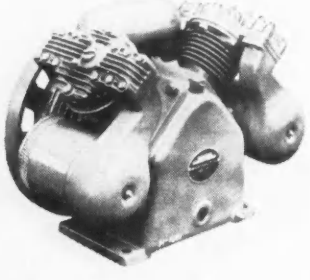

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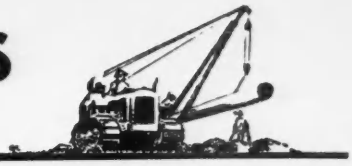

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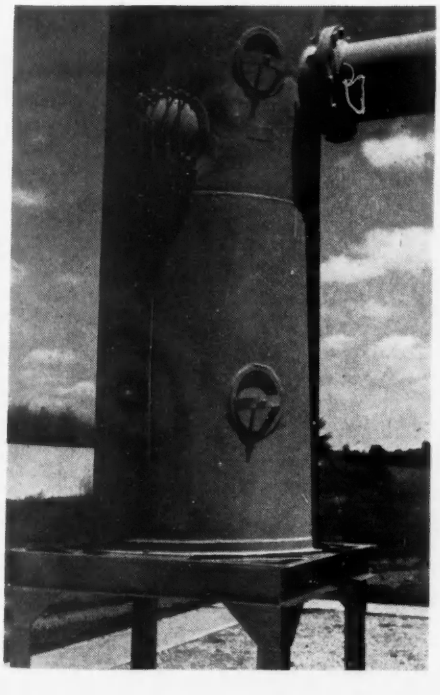
HOW TO—Protect Tools and Gauges

Providing four tool boxes, each equipped with special tools, gauges and other small equipment required by each of the shift engineers, one pipe line company insures that each man will have at hand whatever he may require, and also that he be responsible for the upkeep and proper storage of each item after he has used it.

The four tool boxes, each equipped with a lock for which one of the engineers carries a key, are set on a light framework of steel along one station wall at a site centered so as to make the boxes readily accessible from any engine.

The tool-box frame, resting on six tubular legs, is easily cleaned around and the entire unit may be shifted to a position adjacent to any one engine, whenever work is concentrated there, and tools consequently returned to the proper box as soon as they have been used.

HOW TO—Safeguard Rupture Discs



On mufflers equipped with protection against excessive internal pressures in case of a backfire in the engine to which they are attached, the rupture disc, prestressed to yield in advance of failure of any other portion of the unit, is frequently specified instead of a spring-loaded device.

Since the metal of the disc is relatively thin, and is formed so as to project convexly outward from its flange, there is a possibility the disc may become deformed or injured through accidental contact with plant mobile equipment.

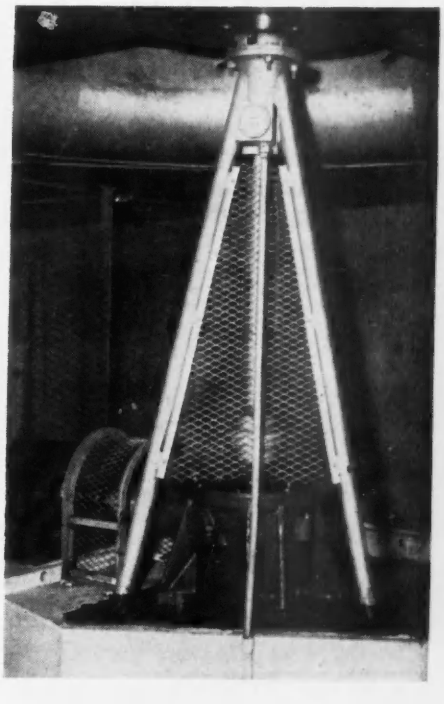
To safeguard these discs, one pipe line company welds four curved rods across the flange which retains the disc in place. These rods are formed so as to enclose the disc without touching it, and are amply heavy to ward off anything which might otherwise strike and injure the disc.

The guard also serves to confine the disc and prevent its being forcefully shot or propelled across the station grounds in case it is completely torn from its flange by a backfire.

HOW TO—Enclose Tower Fan and Shaft

Although access to the motor, gearing and shafting which drive the fans in a cooling tower is infrequent and restricted to station personnel, one pipe line company guards against possible accident by enclosing the vertical shaft within three panels of expanded metal, formed to fit within the three sides of the tripod supporting the upper bearing of the fan drive. These panels, equipped with edge strips, fit closely to lugs welded to the tripod legs, but may readily be removed by releasing the attaching screws when the shaft is to be serviced.

Operation of the fan in case of imbalance is provided against by the installation of a limit-switch device, which automatically cuts off the fan in case the vibration exceeds a predetermined, safe value.



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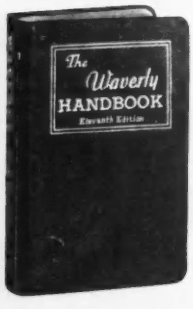

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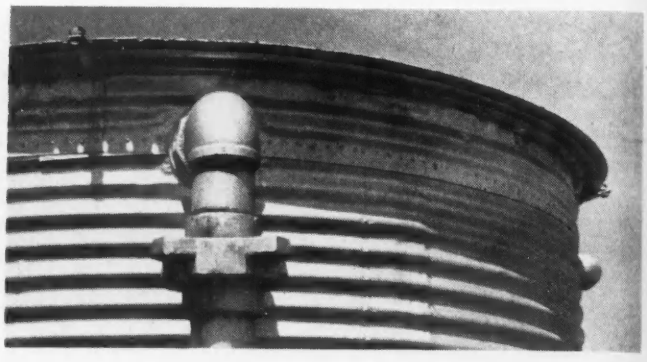
HOW TO—Provide Water Tank Cover



Time and effort may be saved in cleaning out the boiler water storage tank by equipping the tank with a top which may be removed by taking out four bolts. The small corrugated tank, mounted on a base elevated above the boiler, originally had not been equipped with decking, so a shop-made cover was provided.

Made of salvaged tank siding that had been flattened out, welded together, then cut into circular shape, the top was cut to a diameter that allowed it to overhang the tank by six or eight inches. Angle bars of flat steel were fastened at four points around the rim of the tank, the horizontal leg of each bracket projecting over the side of the tank a distance equal to the overhang of the cover. The cover was equipped with flat steel bars to match the angle brackets, and holes were drilled so that they could be bolted together.

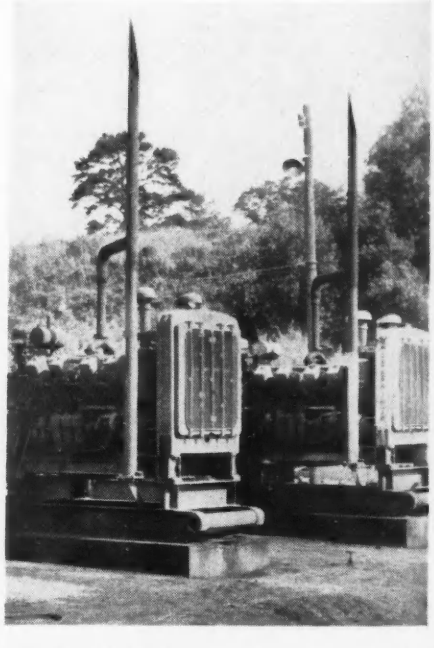
The inexpensive tank cover provides protection from outside sources of foreign material, and is easily removed and reinstalled when the tank is cleaned out or repaired.

HOW TO—Standardize Exhaust Pipes

Unitized field pipe line pumping units can be equipped with standardized engine exhaust pipes so that nothing need be changed in moving the complete unit except to break the oil intake and discharge connections. Illustrated is the method employed by one company to anchor engine exhaust pipes at the company's Nettleton Station in East Texas.

A vertical riser about ten feet long is fitted with a flange at the bottom and "sliced" at the top to provide a relatively large exhaust area as shown. The exhaust line from the engine extends about two feet above the exhaust manifold and makes a horizontal run to connect to the vertical section.

Footing for the vertical exhaust line can be made by extending the cross I-beam on the engine foundation or by welding a short extension to the foundation. Such exhaust pipes have been standardized at this station so that they can be interchanged or prefabricated in the shop for installation in the field. The unit can be removed by simply breaking the connection at the engine manifold and unscrewing the bolts on the flange union at the footing. The offset feature of the exhaust line prevents moisture from accumulating in the exhaust manifold should the engine be shut down during rain. The water which might collect in the pipe falls to the bottom of the vertical section where it leaks out on the ground.



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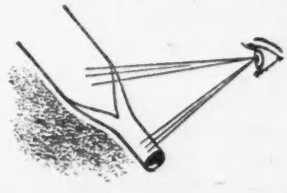
10. **Inspected Inside and Out**—Republic Electric Weld Line Pipe is made from flat-rolled steel both sides of which are closely inspected. Thus, you are assured that the surface which becomes the inside wall when formed into pipe is free from hidden defects.



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HOW TO—

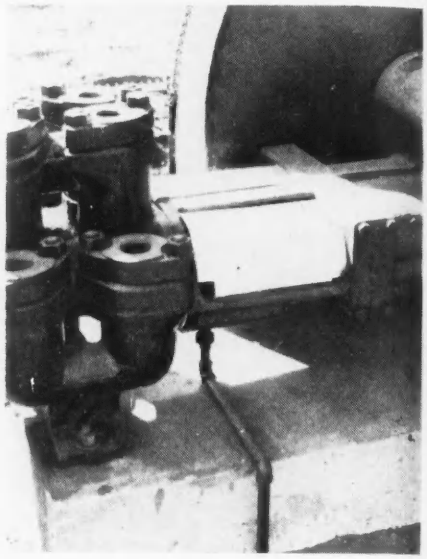
Add Steps to Pump Manifold

Vertical oil pumps containing oiling cups beyond the reach of the station engineer must be equipped so that lubricating the pump can be done safely. To eliminate a hazard which might cause employes to slip or fall from an elevated position when oiling such pumps, one company added the steps illustrated.

Both steps shown are held in position by one bolt on the blanked end of the exhaust manifold of the vertical pump. The lower step was made from a piece of flat plate steel cut to shape and bent to form a bottom step. The upper end of the supporting arm was cut to conform to the flange bolts. A small piece of steel floor plating was tack-welded to the supporting arm to hold the horizontal piece in place. The manifold supported the engineer when oiling the pump. The stepping device is simple, can be removed easily and has eliminated untold accidents due to slipping on the curved surfaces of the manifold.

HOW TO—

Keep Dust Off Oily Pump Rods



Wind-borne sand and dust settling on the oily surfaces of pump rods ultimately will collect in the packing gland and cause considerable scratching and increase the wear on the highly polished pump rod surface. On an exposed crude oil pipe line shipping pump installation in an area where dusty winds are frequent, one company found it desirable to equip its pump with a pair of light sheet aluminum covers which fit over the opening between the power and pump ends of the unit. Curved to fit the opening and having a slight amount of "spring," the covers are easily cut out and fitted to the pump. They are readily removed and replaced when it is necessary to check or service the packing glands.

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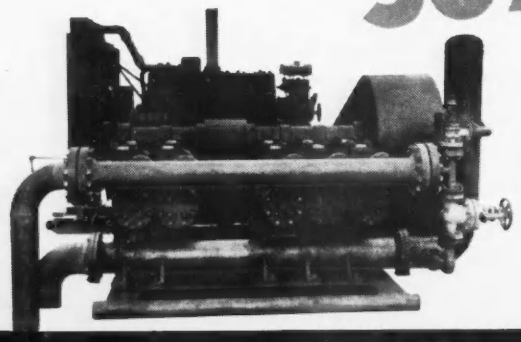

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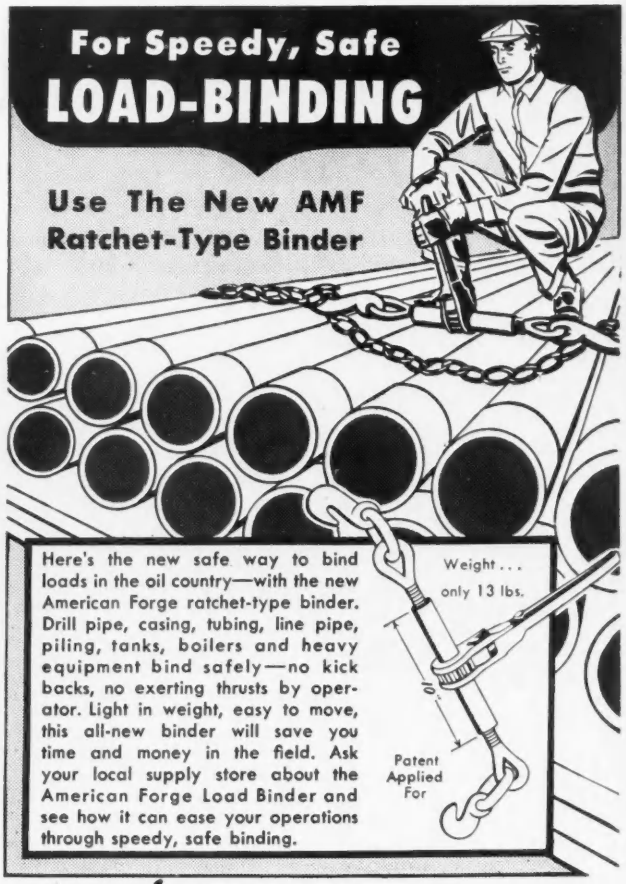

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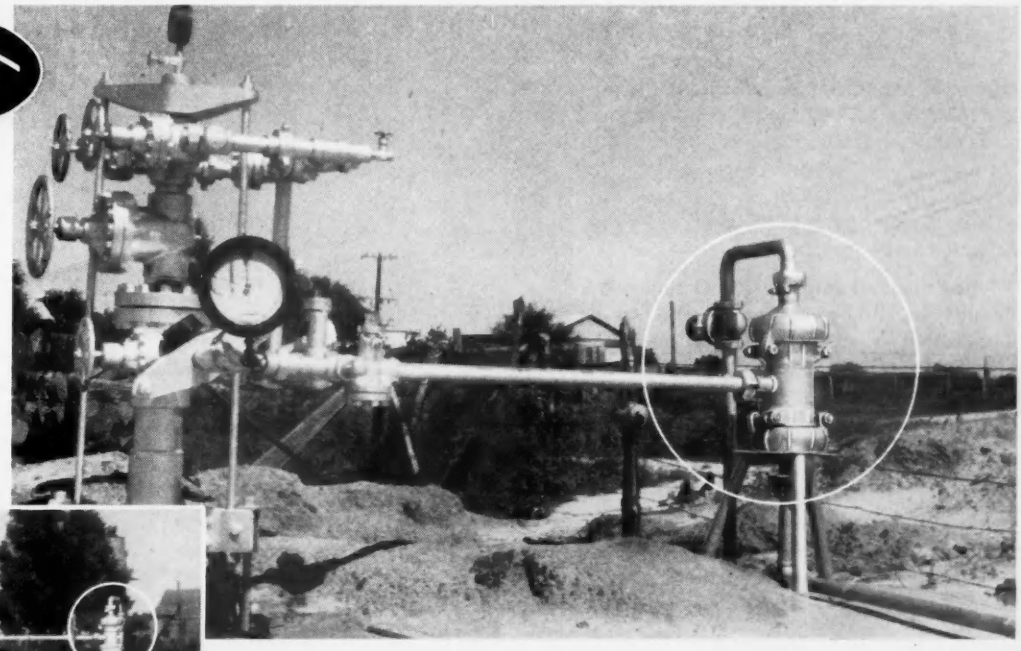

TOP: View of Aerotec Gas Scrubber at the well. The Aerotec unit, in circle, is simple, easy to install and highly efficient.

BOTTOM: Armstrong trap in foreground discharges liquid and solids every 3-4 minutes, from continuous discharge of Aerotec unit in background.

Aerotec Gas Scrubbers are tailored to "at the well" jobs.

These smaller units have proved themselves under severe operating conditions where excessive amounts of liquid, condensate and dust are present in the gas being cleaned.

The 2-year old installation illustrated here precipitates 30 bbls. per MM SCFD of gas. The drips, previously always flooded, were practically dry following installation of this Aerotec Scrubber.

The Aerotec precipitating tube, basis of Aerotec Gas Scrubbers, features a continuous discharge, which in this case was through an Armstrong trap, discharging every 3-4 minutes. This feature eliminates any possibility of sedimentation or clogging up of a sump tank, and the scrubber is always free for continuous operation.

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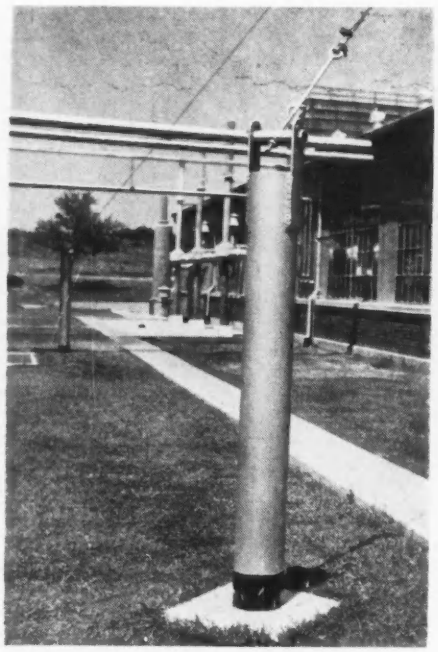
HOW TO—Construct Adjustable Stack Guy Anchor

Clearance around the guy anchorage and station yard appearance can be aided by setting a post in concrete and carrying the guy to the top of such a unit. The post is formed from six-inch pipe, with a pair of strap steel ears or extensions welded to the top. Holes through these extensions take a short length of one-inch pipe which, in turn, is drilled to accommodate the end of the eye-bolt to which the guy is attached. Cotter pins in the ends of the one-inch pipe anchor it in place, yet permit it to turn so as to give a direct pull on the end of the guy.

Adjustment of guy tension is through the nut on the lower end of the eye-bolt, which is easy to get at on the lower side of the one-inch pipe cross member.

The guy post carries the wires high overhead, and clears the station yard of the hazard which is only partially met when shields or guards must be placed on guy wires which come to the ground to be attached.



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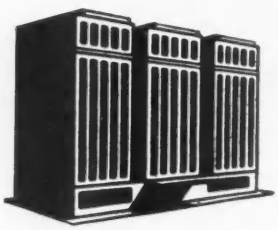
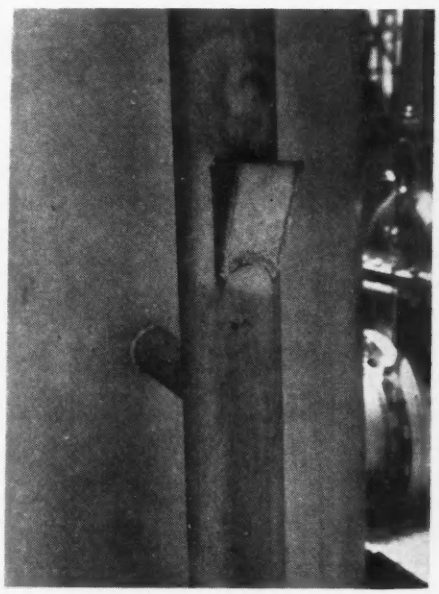
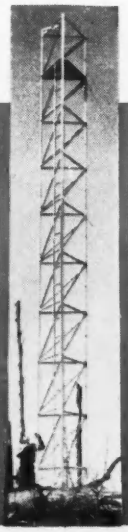


HOW TO—
Check Overflow Of Surge Tank

The surge tank on the cooling system for a battery of compressors in a gas trunk line station normally floats on the water line to the pumps flowing the water through the cooling tower. If the tank fills, the excess is led from the top of the tank through a four-inch line, welded to the tank wall with short spacers of two-inch pipe.

To provide a check of the overflow water, a narrow vertical slot is cut in the pipe wall, and a wedge-shaped cover welded around it. The wide end of the wedge is set upward, so that the device acts as a funnel to confine any water tending to flow out of the slot. At the same time the top of the wedge, being above the top of the slot, provides a slight positive head to prevent overflow so long as the drain at the bottom is open. The slot serves as overflow vent in case of stoppage in the lower line, and gives quick and visible warning of such condition before any damage to equipment can occur.





Helicopter and Portable Towers Simplify Gravity Surveys in Northern Alberta

By GILBERT M. WILSON
Pacific Coast District Editor

CONSIDERABLE savings in time and money have been effected by employment of air-transported gravity meter instruments and portable aluminum positioning towers. Helicopters have been very practical in a gravity survey of a difficult Northern Alberta area. Inaccessible through most of the year, the region was covered in a short time by using the helicopters continuously while surface transportation would have been impossible. This article discusses techniques and procedures used in this successful survey.

A GRAVITY meter survey of some 600,000 acres of densely forested land in northern Alberta recently was completed successfully in the relatively short time of 5½ months by a 14-man survey party of the United Geophysical Company using helicopters and portable, sectionalized aluminum survey towers. Surveyed on a grid of approximately one station per square mile, this large area, approximately 700 miles south of the Arctic Circle, could not have been worked in so short a time had it not been for the unusual combination of equipment employed.

Several factors dictated the desirability and necessity of surveying the area by some method other than the conventional one in which ground parties work with the aid of surface vehicles. These factors were (1) the almost complete lack of roads in this primitive area; (2) the fact that any roads that might have been built could not have been used by surface vehicles for more than about four months out of the year; (3) the thick forest growth which prevented the running of conventional surface traverses; and (4) the extremely high cost, and prohibitively long period of time that would have been required to complete the job with normal surface control methods.

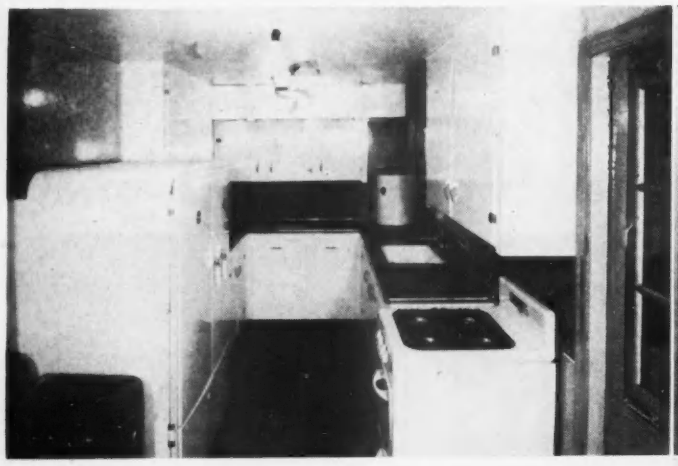
TOP LEFT: View of typical tower installation showing tubular construction and manner of guying. Such a tower is set up at each corner of a township to be surveyed. Man at base of tower is about to ascend ladder and take up position on platform where transit sights are taken on gravity meter-carrying helicopter as the latter flies from station to station within the area.

Towers Useful

The towers proved to be of great value in this thickly wooded area, for their use enabled the survey parties to do their work at or above tree-top level, thereby eliminating costly and time-consuming cutting of roads and trails along which traverses normally would be run. Briefly summarized, the survey operations consisted of positioning a tower at, or as close as possible to each of the four corners of a township. The helicopter, with instrument and operator aboard, systematically worked within this area, landing on cleared spots where gravity meter readings were taken. A man in each of the towers, equipped with a transit and two-way radio, systematically sighted-in and fixed the position of the helicopter as it hovered momentarily above the gravity meter station. Upon receiving word from each of the towers that a fix had been obtained, the pilot landed his ship, the operator lowered his instrument to the ground and took his reading. A similar procedure was followed for each gravity meter station within the area. While one helicopter was busy with survey work, another ship was busy transporting nested tower sections, fuel, supplies and camp equipment to the advance locations.

The increased efficiency realized through this method of conducting a gravity survey resulted not only in a substantial lowering of the per-acre cost of performing the job, but is believed to have established a pattern for the future surveying of the millions of acres in that area that still remain to be explored.

The area surveyed is a rectangular block in the Christina River district some 265 miles northeast of Edmonton. Its eastern boundary lies approximately six miles west of the small station of Chard on the Alberta-Northern Railway, a single track line that is the only means of surface travel in that part of northeastern Alberta. Having an elevation of from 1800 to 2600 feet above sea



At the main camp at Chard, men lived in all-aluminum, well insulated trailers. Equipped with every modern convenience, including electric power generating unit, fuel oil heaters, modern kitchen and lavatory units, the trailers were brought in by railroad at the beginning of the project.

ABOVE LEFT: End view of kitchen, showing water tank and overhead water supply.

ABOVE RIGHT: End view of sleeping trailer showing double bunks and stove.

Exterior design of all trailers.

level, the terrain is generally flat to rolling, with maximum relief of perhaps 600 feet, and is cut up with numerous rivers and streams. Much of the area consisted of muskeg, a soft peaty, moss-like substance often many feet thick, and which, at the time of the spring thaw, becomes a soft spongy morass in which vehicles become hopelessly bogged down. Most of the area is heavily wooded with spruce and aspen, ranging up to two feet in diameter and standing from 30 to 100 feet tall.

The project was started March 1 of this year and was finished August 19. Work was commenced about five weeks before the thaw in order that a single rough road could be bulldozed through the center of the area. The road was used to set up a few advance camps, fuel dumps and control points before the ground softened and became impassable to ground equipment. After May 10, due to the thaw, road-making equipment no longer could be used, and only jeeps could be used in a limited manner for the hauling of water and fuel in the main camp area which was established beside the railroad station at Chard. A half-breed Indian guide familiar with the region was hired to aid in the selection of advance camps and location of principal survey points.

The individual towers, standing 48 feet high above the ground and weighing only approximately 250 pounds, were made of one-inch diameter aluminum alloy tubing. They were built in 12-foot sections, each section attached to the other by means of 12-inch sleeves that telescoped over the adjoining leg sections. Each tower had three legs and was of all-welded construction. Seen in cross-section, the tower structure was an equilateral triangle measuring 48 inches on each side, a leg being located at each point of the triangle. To facilitate transportation by helicopter between stations, each section was designed so that it could be collapsed into a flat "package" measuring 48 inches wide, 12 feet long and 4 inches thick. Laid one atop the other, these packages were carried by helicopter from one tower station to another. Ordinarily, the helicopter with pilot and extra man aboard, could carry two sections on each trip. A minimum of handling was necessary to transport the sections, for the float-equipped helicopter was set down astride the nested sections, quick-fastening lugs attached to the under side of the helicopter, and the sections then were ready to be carried away.

A device built in the top section of each tower greatly simplified and speeded the work of the transit operator working from the top platform. Instead of mounting the transit on a tripod or stand in the center of the small triangular platform, where it would tend to restrict the movement of the operator, an L-shaped, movable transit arm was devised. The transit was mounted on a fitting at the end of an 18-inch long arm, to the other end of which was welded, at right angles, a short piece of rod with an outside diameter equal to the inside diameter of the tower leg tubing material. In operation, the short vertical leg was inserted into any one of the three exposed tower legs, and the instrument swung over to the center of the tower. After the shot was taken, the operator could swing the instrument out over the side of the tower, leaving him unrestricted use of the platform. Shifting the transit arm from one leg to another permitted him to take sights through a full range of 360 degrees.

Although the 48-foot tower generally was used for the majority of the stations, some installations required that a 72-foot tower be used, the latter calling for the assembly of six of the 12-foot sections. Some stations required only a 12-foot tower. Height of the towers depended upon the terrain and height of trees in the particular area being worked. Generally, such stations were set up on

the highest vantage points and where there was a minimum interference from trees. Towers were guyed three ways, every 12 feet of length, using airplane-type control cable in 15-foot lengths and each equipped with hook and eye fittings for quick attaching. Guy wires were anchored to stakes or trees, whichever was most convenient.

Four survey towers generally were used on the job, although three could be used satisfactorily while the fourth was being transported to a new area. An attempt was made to keep the towers on township corners, but often this was impossible because of the nature of the terrain, presence of streams or unusually heavy tree growth. At times, towers were only three miles apart, but at other times they might be as far as 15 miles apart. On the average, however, shots were confined to distances of not more than eight miles.

As soon as the towers were set up on the corners of a particular area, and their positions tied in with previously-established known bases or markers, gravity meter survey work was able to start work within the area. Using two-way aircraft type radios, tower men were able to communicate not only with each other, but with the helicopter that carried the gravity meter and operator. Gravity meter operations were conducted in the following manner: The helicopter approached the area and when it was over the proper position, it hovered motionless just above tree top level while each of the tower operators took a fix on its position. A minimum of three cuts was taken on the helicopter's position, thus positively locating it in relation to the towers. As soon as the towers signalled that they had completed their sights, the helicopter descended vertically and landed. The gravity meter operator opened a trap door in the bottom of the helicopter and lowered his instrument until its fixed legs rested solidly on the ground. He then took his gravity reading and recorded the elevation as indicated by an electro-altimeter carried in the ship. Accurate vertical control of the survey was kept with this instrument, elevation readings being corrected each night with a base meter set up at the advance field camp. As soon as readings were completed at a gravity station, the helicopter took off for the next station where sights again were taken by the tower men. From two to three days usually were required to work one of the quadrilateral areas, an average of about 26 gravity meter stations being made and surveyed in each eight-hour day.

Regional map showing (in hatched area) the location of the 600,000-acre block of ground that was surveyed in the relatively short time of 5½ months. Only access to the area was by the single track railroad running between Edmonton and Waterways.

Before ground thawed, a single road was cut through to center of area to permit moving in fuel, supplies and camp equipment for auxiliary camps. Here, tractor-trailer unit, and jeeps are moving equipment over the road. After thaw, roads in interior became impassable. Note density of tree growth.

Back-Sight Control System

A back-sight control system was employed which reduced to a minimum any possibility of error in accurately plotting the location of towers at each new area. One of the four towers, usually one that was located most favorably on elevated ground, was considered a key tower. This tower was the last one to be moved when operations were shifted to the new, adjoining area. The first tower that was moved to the new area was positioned in the most favorable spot available, and where it could be seen by those towers still in the old quadrilateral. This first tower then was considered as the key tower and its position accurately tied in and fixed by the remaining towers, including the previous key tower, before the latter was shifted to the new scene of operations. Additional checks were made each morning, when, before survey operations were started, each tower sighted in his position with the key tower. Work was done only when ideal weather existed, when visibility was good and when wind velocities did not exceed 15 miles per hour. Weather was checked by radio with Edmonton and Fort McMurray every day.

Temporary Camps Within Area

The main camp and base of operations for the survey job was established at Chard, the small railroad station that boasted a single wooden structure which served as both station and dwelling for the lone station master. Because survey operations were carried on so far from this main camp, temporary work camps were set up in the field, these camps being shifted from time to time to keep up with the scene of operations. Field

personnel using these camps were provided with tents, sleeping bags, portable stoves, food supplies and other equipment. These camps served also as fuel depots for the helicopters, and were equipped with such items as spare batteries, battery chargers and spare equipment.

The second helicopter was kept busy moving these camps, bringing supplies, gasoline and oil out from the main camp, transporting personnel and doing various other necessary jobs. Hauling the odd tower from the nearly-completed survey area to the new scene of operations was one of the jobs of the second helicopter.

An ax-man generally accompanied the pilot of the second helicopter so that timber and brush could be cleared from gravity stations and tower sites. An area approximately 70 feet in diameter usually was necessary for the safe landing and take-off of the helicopter. Ordinarily, if a new site had to be cleared of heavy growth, one or two men were taken in and left to clear the area while the helicopter proceeded with other phases of the work, picking up the men after they had completed the clearing job. In some instances, where terrain or growth conditions made it necessary, a man equipped with an ax would descend on a rope ladder while the helicopter hovered over the area. Usually, in a short while, the man could have the area sufficiently cleared to allow the helicopter to land.

All fuel was transported from the main camp to the advance camps in five-gallon cans. Some idea of the magnitude of this job alone can be gained from the fact that the helicopter, with pilot and one man aboard, could carry 250 pounds of fuel, but in the course of making the round trip between the main camp and the more remote advance camps, the helicopter would consume 50 pounds of fuel!

Horizontal control was extremely accurate considering the nature of the terrain and the almost complete absence of permanent bench marks upon which survey parties could depend in the more remote parts of the area. When the job was completed, the traverse, or triangulation network, was closed and found to be less than 300 feet off.

A pilot and mechanic were assigned to each helicopter. All servicing was done at the main camp at Chard, the mechanics servicing the helicopters each night and having them ready for next morning. The ships flew an average of 150 hours per month each, which, it is believed, is a record for this particular make, and possibly for all makes of helicopters. It is still more a remarkable accomplishment when it is realized that no ship failure occurred during the course of survey operations.

Two helicopters were used in the project, one which carried the gravity meter and operator, and one which transported towers, camp equipment, fuel, supplies and personnel. Both units are shown here in a clearing in the generally wooded survey area.

Without the use of helicopters, the job could not have been completed in so short a time, nor for as little a cost per acre. Surface transportation would have been out of the question for the greater part of the period during which the survey was made. The only road into the area was a single 56-mile long road that was made with a bulldozer during the short time before the thaw when the ground was hard enough to support vehicles. This single road started at the eastern boundary, went through to the approximate center of the area, then turned south to the southern edge, returning to the railroad near the southeastern corner.

Costly Work

Some idea of the costs involved in this comparatively small amount of road work can be gained from the fact that even under the most ideal of conditions, when the ground still was frozen, a bulldozer could cut only about 1½ miles of road per day, and this at a cost of about $150 per day. At one particularly difficult point in the road where it crossed the still-frozen Christina River, five days were required for the bulldozer to cut a road down the 300-foot high bank on one side and back up the other side.

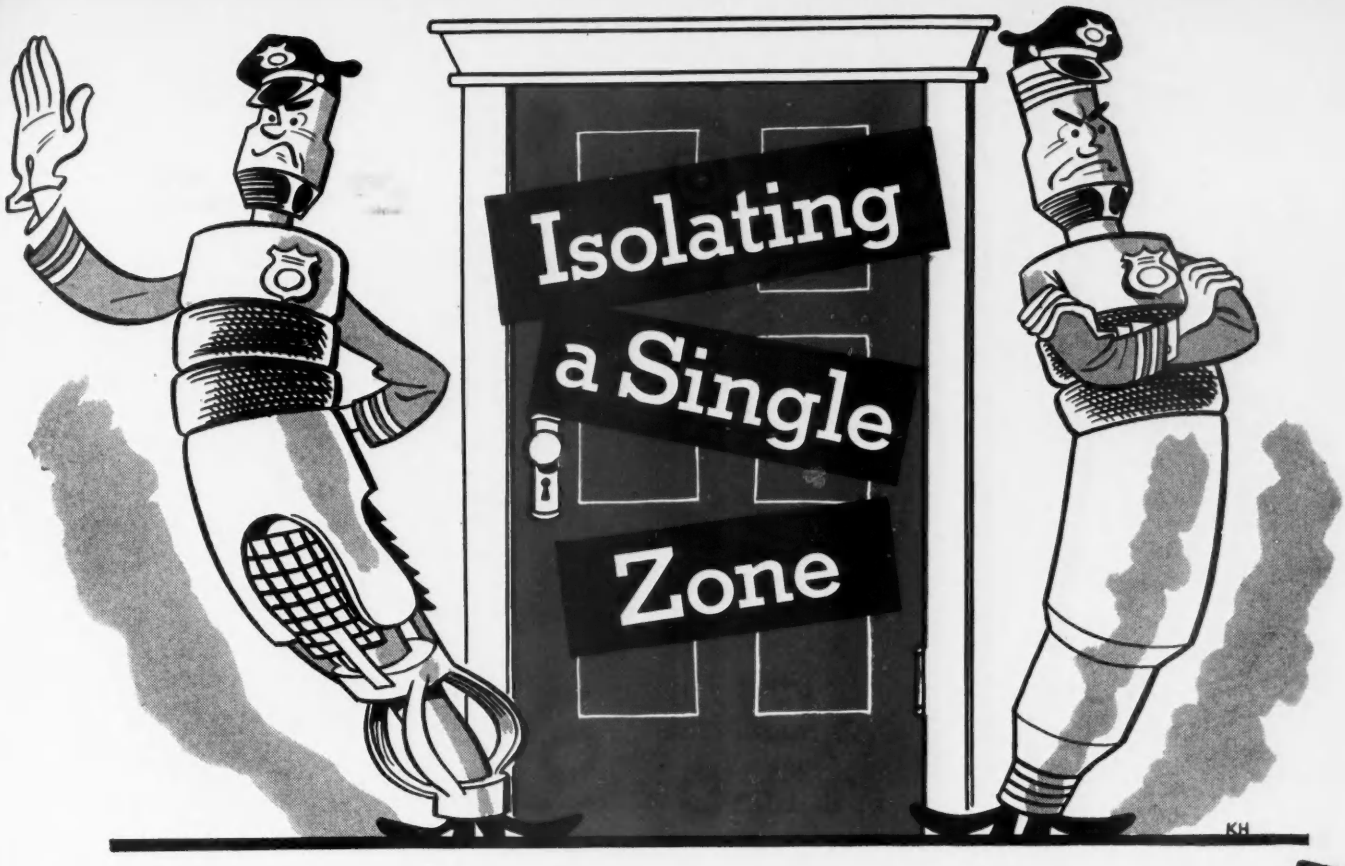
If the survey job had been done using conventional ground party methods, it is estimated it would have been necessary to cut about 720 miles of roads through the area. Much more time also would have been required to accomplish the same results, assuming that gravity stations were made on a grid of one per square mile. Added to this cost of slower-working ground parties would have been the additional expense occasioned by the fact that ground transportation is possible for only about four months of the year, necessitating costly periods of inactivity during which crews and equipment would have to be moved elsewhere. An elapsed time of from three to four years probably would have been required to complete the job had conventional ground survey methods been used.

Living conditions for the men were exceptionally good considering the remoteness of the area. At the main camp at Chard, the men lived in specially-designed, well insulated trailers equipped with every modern convenience. Four 8 x 16-foot trailers were used. Of all-welded frame construction, the units had corrugated aluminum exterior walls and plywood interior walls. Two served as sleeping quarters accommodating four men each; one served as a kitchen unit, and the fourth was a utility unit, containing showers, lavatories, refrigerator power plant and dry food storage. Electricity was generated by a small power-driven unit, and each trailer was equipped with a 65,000 BTU diesel-oil fired heater.

The first shipment of camp supplies was brought in on four flat cars and two boxcars, and consisted of the trailers, helicopters, fuel supplies, dry food and general supplies sufficient to last approximately three months. Fresh food supplies were brought in regularly by the train which came through three times a week. A 2200-foot landing strip graded out at Chard could accommodate up to medium size, single engine airplanes, and enabled supervisory personnel to fly to and from the scene of operations whenever necessary

Flying was the fastest and most dependable means of traveling, for the 265-mile trip from Edmonton to Chard by rail required about 15 hours and only three trains a week were scheduled. The road bed and bridges, at some points along the route, are so insecure due to the nature of the ground that the train had to proceed cautiously at a one- to four-mile-per-hour rate. The only other alternative, if a passenger did not wish to wait for the three-times-weekly train, was to "charter" a motorized hand car, don heavy flying-suit type clothing and set out for his destination.

The over-all cost of this particular job, including expenses incurred in connection with setting up and maintaining camps and transporting equipment and personnel, was approximately 22 cents per acre. Considering the nature of the terrain and the problems encountered, this is believed to be a remarkably low figure. This is especially so when it is realized that the total time on the job included a number of days when work had to be halted due to adverse flying weather, and several occasions when work had to be stopped during a hazardous period when danger of forest fires existed. The technique of using helicopters and portable survey towers on this job is believed to have established a pattern for future exploratory work which will be conducted in this remote region.



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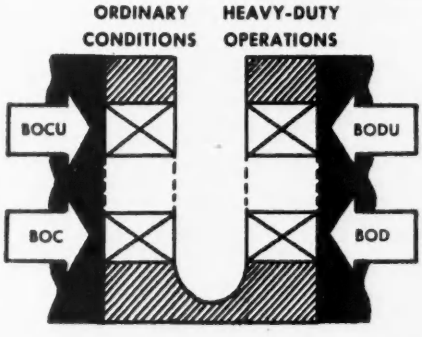

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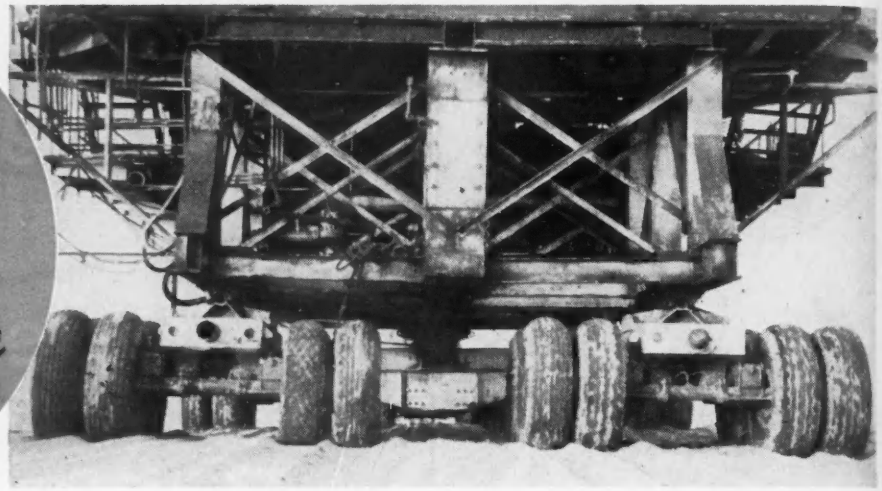
Unitized Drilling Rigs in Saudi Arabia



Close-up of rear dollies and substructure under drawworks-engine unit.

By
D. J. SULLIVAN
and
F. A. HILTON

ONE of the interesting features of the oil drilling business as practiced by Arabian American Oil Company in Saudi Arabia has been the extent to which the policy of "unitization" has been extended. Unitization is a term to be used with care, as it has been applied to a wide variety of practices, all resulting in the grouping of parts of drilling machinery for the primary purpose of moving each group as a unit without breaking it into its various parts. The degree of this grouping has varied markedly.

Aramco's program is novel because of the few large units that make up the complete rig. The units can be made large since there are no road or bridge restrictions to limit their size. However, problems do exist. One was to determine a method of moving heavy equipment over the soft, fine desert sands.

The drilling rig includes three major units, consisting of the drawworks and engines, a 136-foot derrick, and the mud pumps. In addition, there are five smaller auxiliary units, including a 1000-barrel mud storage unit, a mud-mixing platform, a light and power plant, a shaker tank unit, and a casing rack and walkway unit. The rig has been used to drill to 12,000 feet.

The units of the rig were designed to be moved without the use of a crane. Also, they were designed in such a manner that a minimum number of changes were required in the basic machinery delivered from the manufacturers. The units as mentioned above can be moved with three tractor-trucks, one light A-frame truck, and two crawler tractors. A complete move of all of the units, from the time the rig is released to the time the next well is spudded, can be made in four days or less. Moves can be made in an area without roads over a distance of ten miles in this period of time.

Each of the three major units, including the auxiliary equipment and supplies, weighs in excess of 100 tons. The drawworks unit, which weighs approximately 120 tons, is the heaviest of the three units. This load approaches the load limitations of the present running gear and tires.

Derrick Unit

This unit consists essentially of a standard 136- x 30-foot base derrick with all of the attached equipment integral with the derrick, and a specially designed substructure.

The substructure is designed so that rubber-tired dollies may be mounted under it as running gear during a move. The dollies are removed from the unit during the assembly of the rig at a new drilling location and are used for other purposes until the equipment is to be moved.

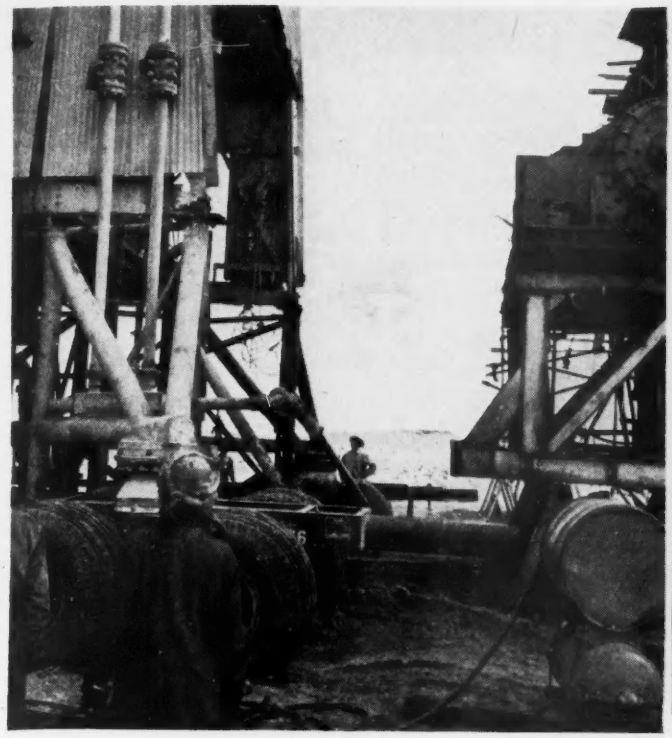
The derrick substructure was designed for three-point suspension during moving. The points of support were spread sufficiently to provide stability while the unit was being moved over rough terrain. By use of the three-point suspension and complete oscillation of the dollies, strains on the steel structure created by movement over uneven ground are reduced to a minimum.

The substructure has two outriggers at the corners on the drawworks side of the unit. The dollies are mounted under these supporting structural members to provide two of the three points of suspension. The outriggers provide stability and they are designed in such a manner that the unit has to be raised only about two feet to install the dollies. The third point of suspension is provided by an outrigger that serves both as a pipe ramp and a structural member.

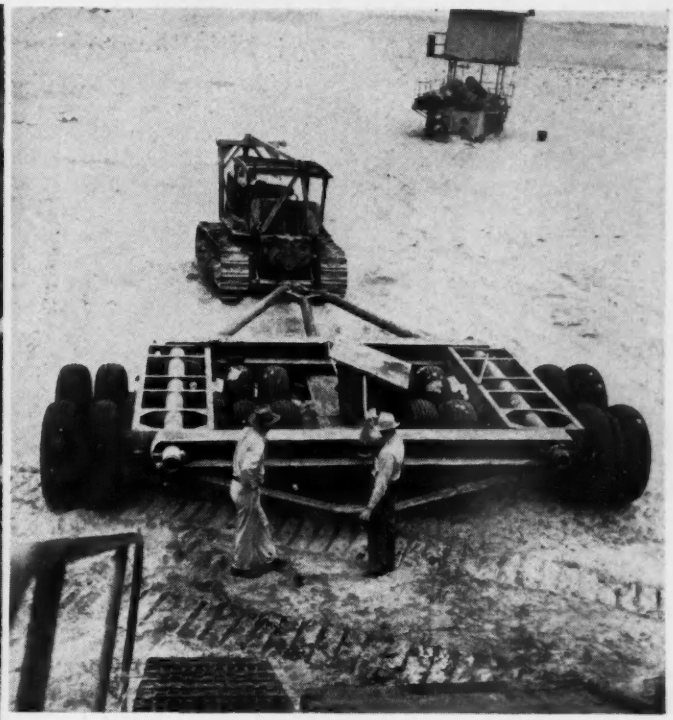
The standard rubber-tired dolly being used in Saudi Arabia is a dual axle dual-tired dolly with two sets of springs, a swivel trunnion, and a transverse oscillating frame. The size of the eight-ply, low pressure, special sand tires is 14:00 x 20 with an unload diameter of four feet. They provide approximately five times as much bearing area at a pressure of 25 pounds per square inch as is provided by a regular high pressure 6:00 x 16 automobile tire inflated to a pressure of 28 psi. These tires have been developed after years of extensive research in desert sand operation and are designed to provide maximum flotation with minimum rolling resistance.

The standard dolly is designed to al-

BY TAKING ADVANTAGE of topographic conditions which make possible the unitization of drilling rigs for movement in large units, operators in Saudi Arabia have saved much time and money. Cost of unitizing has been recovered in less than a year through direct and indirect economies which include reduced transportation cost, less damage to equipment, and considerably smaller losses of fittings and small parts. A 12,000-foot rig is moved in three major and five smaller units.



Derrick unit mounted on wheels starting to pull away from the drawworks-engine unit. Note tubular trestles supporting drawworks substructure.



Front dolly being backed into position under front end of derrick.

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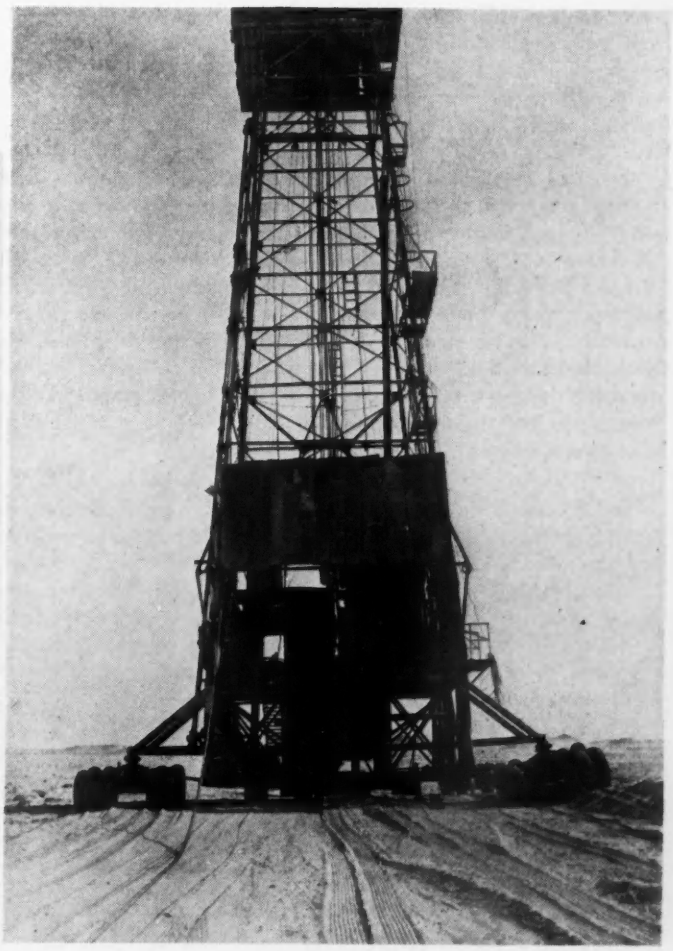
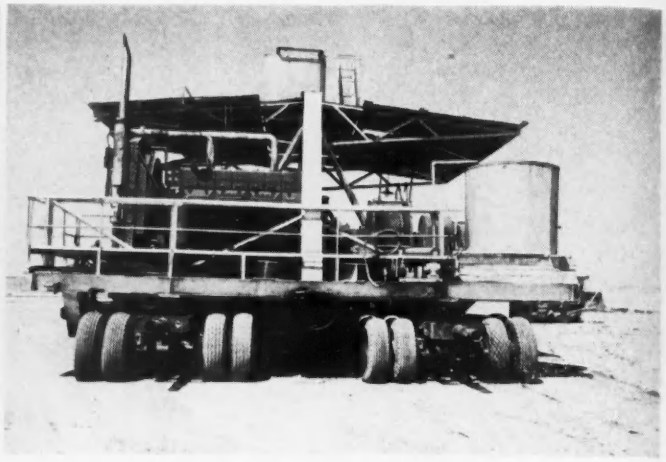
Hundred-ton air-operated hydraulic jack is used to raise all main units to place or remove dollies.



Unitized derrick moving over moderately irregular terrain. Note position of rear dolly (extreme right).



LEFT: Front dolly used in moving all major units of the drilling rig. The support shown in the center of the picture ends in a ball and socket joint which permits free movement of the dolly with minimum vertical movement of the supporting load.
RIGHT: Rear view of mud pump unit.

low oscillation about perpendicular axes that are parallel to the ground surface. The bracket attached to the derrick outrigger has a concave surface which bears on a matched saddle on the dolly. This bearing is manufactured from double extra heavy pipe. The entire load is supported on the dolly through the fabricated saddle bolted to the dolly frame. The special bearing provides oscillation about the axis of the bearing and the dolly provides oscillation about its axles.

A double dolly which is fabricated from two single dollies placed side by side is used as the lead dolly. The forward portion of the distributed load from the derrick unit is supported by a large ball and socket. The ten-inch diameter ball is welded to an inverted steel pyramid, and the base of the pyramid is bolted to the derrick unit. The ball bears in a socket mounted on the frame of the dolly. This ball and socket acts as a pivot point and enables the double dolly to be steerable. Oscillation for each individual dolly is permitted around a heavy piece of pipe passing through each of the dolly frames. Oscillation perpendicular to the bar is provided about the dolly axles.

One standard dolly is placed under each rear outrigger, and the double dolly is placed under the pipe ramp. The total weight of the unit, including the dollies, is approximately 200,000 pounds. The load is transported over any kind of terrain on the 32 tires of the dollies.

The derrick is integral with the substructure. The traveling block and crown block remain strung during a move. A heavy bar is placed under the rotary machine beams and through the eyes of the elevator links. A pull is taken on the drilling line, and the drilling line is clamped to a holddown line anchored to the structure. Then, the drilling line is removed from the drawworks and is coiled on the derrick floor. The rathole casing is pulled and is left standing in the derrick. The derrick remains completely rigged during a move, with the rotary machine in position; the tongs strung and tied back; the stand pipes intact; and the swivel ready to be picked up. All of the lighting fixtures are left in place. Plug connections are provided for the derrick lighting system. Water lines are permanently installed on the unit. Steel hose with flexible joints and unions enable the connection to water mains to be made easily; thus, perfect alignment with other units is not necessary.

The drawworks side of the derrick substructure has been designed so that the protruding portion of the drawworks unit matches the inset in the substructure. Two removable braces are installed in the inset to provide adequate bracing when the drawworks unit is pulled away from the derrick unit. Also, the substructure is designed so that there will be sufficient clearance to move the unit over a standard Christmas tree after the well is completed.

Timber Matting

The derrick substructure bears on 3 x 12-inch sectionalized timber matting. It has been found that this type of matting is excellent even on relatively loose dune sand. However, care must be taken to prevent the sand below the matting from being washed out by water or drilling fluids. The derrick unit is spotted over the timber matting. Portable air operated 100-ton jacks with a maximum lift of 30 inches are used to lift the unit so that the dollies may be removed.

After the dollies are removed, the unit is lowered onto pipe rollers placed on the mats. Tractors are used to align the derrick unit over the cellar. The rollers are removed after the derrick is aligned, and shims are used to level the derrick when it is in place.

While the derrick unit can be moved at the rate of five miles per hour over flat terrain, the average moving rate in most areas is one mile per hour.

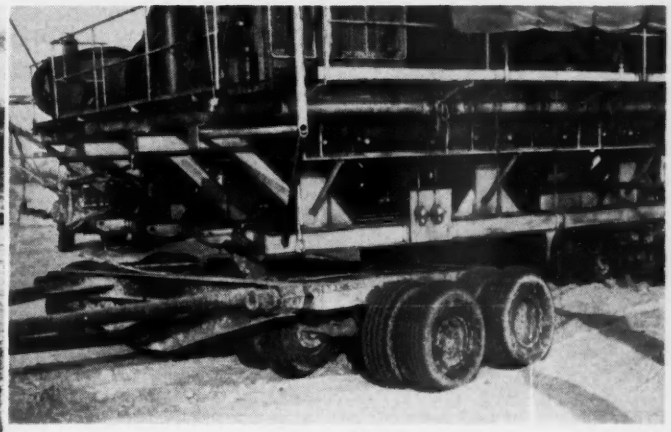
The drawworks and engine unit consists of a large drawworks, three 6-cylinder diesel engines, compounding transmissions, a welded substructure, blowout preventer control manifolding and pump and miscellaneous accessories.

The substructure for this unit was fabricated from structural steel and is similar to substructures normally employed except that the unit was made as a rigid structure. Aramco has two types of engine drives. One is direct to the transmission, and the other is through hydraulic couplings. The center of gravity for the unit with hydraulic couplings is several feet to the driller's side of the center line of the unit. The offset center of gravity must be considered when the unit is being towed so that maximum stability is maintained.

Piping for the drawworks unit is permanently installed in the substructure. All connections on the piping are either rubber hose or steel pipe with flexible joints. Electrical connections between the power plant unit and the derrick unit are made by plugs and receptacles. In this way, the aid of an electrician is not required during rigging operations. The engine fuel, air, lubricating oil and crankcase drain manifolds are permanently installed, and are disconnected only during repair operations or when an engine change is being made. An engine can be changed without interrupting operations.

The lubricating oil manifolding is a novel feature of the unit. It is a closed system. This reduces to a minimum the amount of sand and dirt that normally would be blown into the lubricating oil system. The manifolding is arranged so that lubricating oil is pumped directly from sealed drums through filters to the

The mat of 3x12-inch planking, laid on level sand, forms the only support for the drawworks-engine unit.



Close-up of front dolly supporting drawworks-engine unit.

crankcases of each of the engines. The drilling crews are not permitted to use open containers for the handling of crankcase oil.

The unit is transported on two single dollies at the drawworks end and on one double steerable dolly at the engine end. The dollies are the same as those used to transport the derrick unit. The unit is towed from the engine end and is backed into the derrick unit. The protruding drawworks is engaged with the inset in the derrick unit and the unit is spotted within six inches, both laterally and longitudinally with the tractors. The unit is jacked and the dollies are removed. Five "saw-horse" type structure members fabricated from used 6⅝-inch drill pipe are used to provide the proper elevation relationship between the drawworks and the derrick floor. The unit is lowered onto the "saw-horses" which bear on the 3- x 12-inch matting, and then is aligned accurately by sliding into place. No tie-downs are required because the unit is heavy enough to remain steady under normal drilling and fishing operations.

Normally, the unit can be spotted, the running gear can be removed and the unit can be aligned in four hours. Three hours usually are required to jack the unit and install the running gear.

For hauls in excess of 150 miles, which will require more than six days, it may not be economical to move the unit with tractors. In long hauls the slowness of the tractors overbalances the advantages of the unitization.

Mud Pump Unit

This unit is composed of one 7¾- x 16-inch pump, one 7¾- x 18-inch pump, one 8-cylinder diesel engine with a hydraulic coupling, a suction pit, miscellaneous tanks, and complete mud pump suction and discharge manifolding.

A welded structural steel base supports the equipment. The structure has a gooseneck at each end and is designed as a single truss to prevent bending.

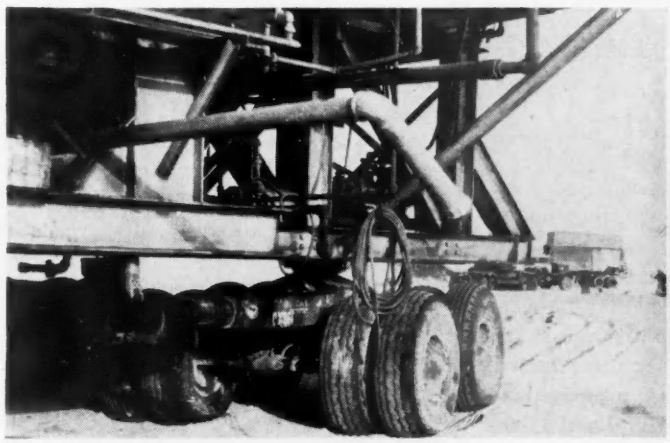
The unit is transported on two single dollies under the rear gooseneck and one double dolly under the front gooseneck. The double gooseneck design reduces the amount of jacking that might be required under a different design.

The unit is towed to a location by crawler tractors. It is jacked and the dollies are removed, and the unit is lowered into rollers on timber matting. The unit is aligned so that the V-belt sheave of the No. 1 pump can be aligned with the sheave on the compounding transmission of the drawworks unit. All external pipe connections are made by rubber hose or steel pipe with flexible joints. Belt stretch is compensated for by the adjustment of an idler pully.

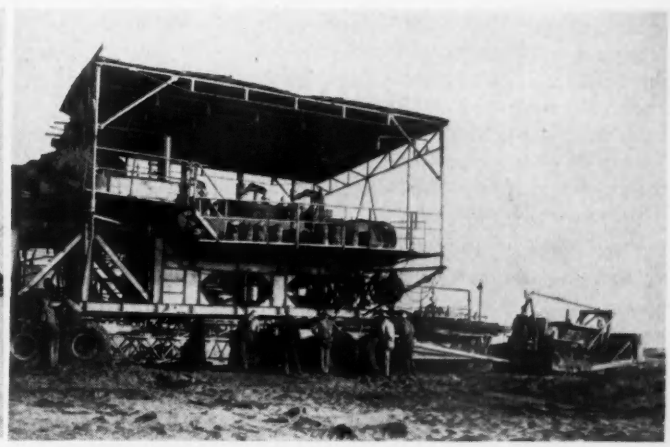
A diesel fuel tank is placed on top of the truss of this unit. The elevated tank provides gravity flow of fuel to the engine in this unit, the engines on the drawworks unit and the engines on the generators. The unit is designed so that it can be moved with the tank filled with fuel.

Auxiliary Equipment

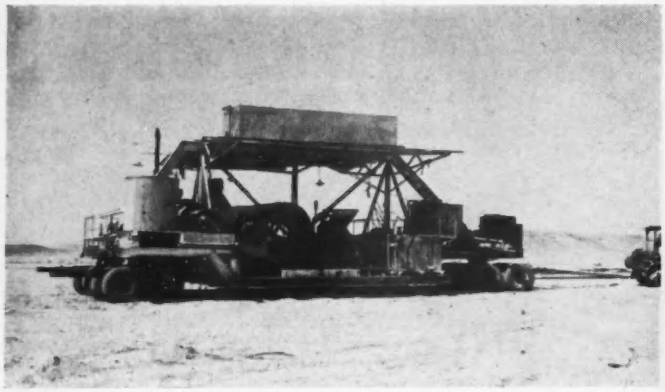
The unitized mud storage tank unit consists of two 500-barrel bolted steel tanks complete with all necessary piping for filling, discharging and agitating the drilling mud. This unit was designed to

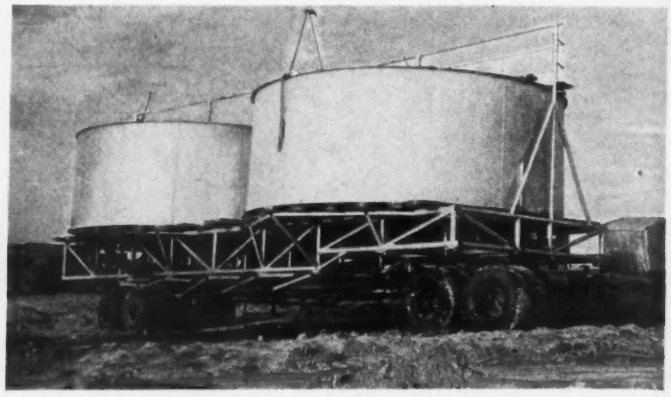


Close-up of rear dolly supporting drawworks-engine unit. Note permanent manifolding of water and mud lines.



Drawworks-engine unit. Unit has been jacked up and both front and rear dollies are being pushed into position prior to lowering the unit onto the dollies for travel.





LEFT: Side view of mud pump unit on the move, showing left to right, small oil tank, mud pump, and mud pit. Square tank on top is for diesel fuel. RIGHT: Auxiliary unit for mud storage tanks. It supports two 500-barrel tanks.

eliminate the excessive damage caused to tanks by cranes and winch trucks during handling. Once the units are assembled, the tanks are subject to natural deterioration only and suffer no handling damage. They are completely rigged at all times and require only the connection of several unions to place the unit in operation.

The supporting structure is fabricated as a semi-trailer from discarded drill pipe and is sufficiently strong to support a total weight of 500,000 pounds. The unit normally is transported with the tanks empty. The lower supporting members are hinged to the main structure and in transit they are folded upward and held in the clear. During a move, one end of the unit is supported by the fifth wheel of a tractor truck and the other end is supported by a single dolly.

In position, the tanks are sufficiently high for gravity flow of the drilling fluid to the suction pit.

The generator plant and workshop consists of two 25 kva diesel electric generator sets, electric motor driven compressor, an air receiver, a control panel for dynamatic brakes, and cable and receptacles for all rig lighting.

The structure is made in the form of a semi-trailer and is transported by placing running gear under the rear of the unit and backing a tractor truck under the gooseneck. On location the unit rests approximately four feet off the ground. Its supporting structure is welded to the unit and is hinged so that it is transported with the unit.

Power and air are available to the rig as soon as the unit is landed and the necessary lines are attached. Rubber hose is used for air lines. The lines are attached by connecting unions and all electrical leads are equipped with plug-in type connections.

The shaker and settling tank is a standard tank 27 feet long upon which is located two shale shakers. A 100-barrel water circulating tank (for hydraulic couplings and brake rims) and the "dog house" are placed on an elevated supporting structure which is welded to the tank framework. The circulating tank and dog house are positioned so that the dog house floor is level with the derrick floor.

Combining these pieces cuts down handling costs and further reduces equipment damage.

About the Authors

D. J. SULLIVAN graduated from the University of California and then worked for The Texas Company two years as a petroleum engineer in Southern California. Transferring to the Foreign department as drilling foreman, he served in Colombia for approximately 2½ years. He was with the Navy four years during the war and discharged with the rank of lieutenant commander, after which he went to Saudi Arabia as a drilling equipment engineer for Aramco. He is now district drilling superintendent there.

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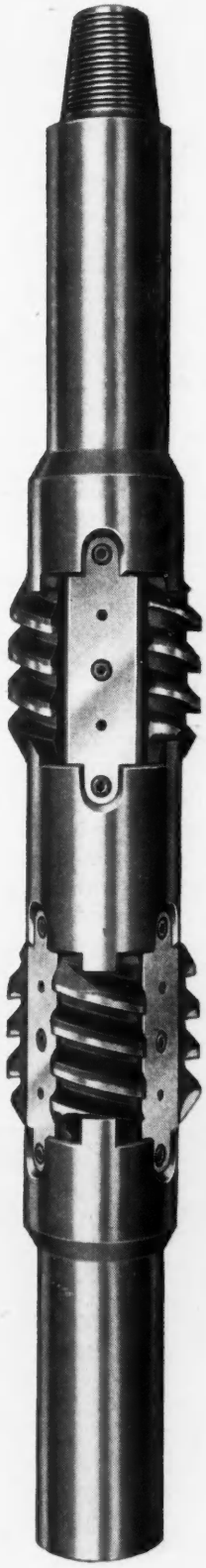
F. A. HILTON graduated from the University of California in 1941, after which he worked for Tide Water Associated Oil Company two years. In 1943 he went to Saudi Arabia as assistant petroleum engineer for Aramco. In 1945 he was promoted to petroleum engineer, and since 1946 has been petroleum engineer in Aramco's home office.

Standard racks and walkway are now in use. Preliminary plans have been made to construct a 60- x 8-foot walkway in the form of a long trailer, the rear part of which will be attached to the derrick ramp. To transport the unit, a dolly will be placed under derrick end of the walkway, and the other end will be provided with a king pin for attachment to the fifth wheel of a tractor truck. Therefore, this unit will be similar to a semi-trailer. The side stringers and auxiliary racks will be manufactured as welded box type members 40 and 20 feet long, 6 feet wide, and approximately 4 feet high. When moving, all side members including the auxiliary racks would be placed on the walkway and the entire load would be transported, using a single tractor truck and a dolly.

The unitization of the drilling rigs in the manner discussed above has proven exceedingly practical. Time has been saved on rig moves. Charges for transportation equipment have been reduced. This method of unitization practically has eliminated the loss of fittings and miscellaneous small parts. Indirect savings have resulted from reduced damage to equipment. It has been demonstrated that sufficient money can be saved in less than one year to pay for the cost of the unitization work.

Unitization on the scale adopted in Saudi Arabia is practical only in countries where the wide open spaces remain an actual fact. Aramco's drilling rig units, covering a path 30 to 50 feet wide, could not be used on modern roads in the U. S. The unitization has been specially adapted to the country in which Aramco operates. It is a desert method fitted to desert conditions. It is an accomplishment in transportation which has been achieved because the men on the job have recognized and have taken advantage of existing conditions in overcoming handicaps.

tool with no trouble. They *know* that the tubing or liner can be run easily and safely, and that packers and cement retainers will run-in readily and seal-off perfectly against the clean, smooth inner surface of the casing. Not only is the well then ready for immediate completion, but it will be left with the "working surface" safe for all future down-hole work. Isn't the reasonable rental charge for a Baker Casing Scraper cheap insurance for leaving your well in perfect condition?



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Field reports on the ROTO-VERT Casing Scraper prove its efficiency when used as recommended for the removal of a large number of burrs from gun-shot holes, and possible bullets imbedded in the casing. A ROTO-VERT used on two consecutive jobs scraped a total of 1,548 perforation burrs WITH THE SAME SET OF BLADE BLOCKS, and the blades were still in usable condition. Further proof of the complete, clean removal of burrs was provided when the swab cups used in connection with washing the perforations in both wells, were found upon removal from the well, to be in good condition.

You'll always be glad you scraped the "working surface" of your casing

Descriptive literature is available on both types of Baker Casing Scrapers—or, better yet, ask the Baker representative in your area how you profit when you use a Baker Casing Scraper to "KEEP IT CLEAN."

BAKER OIL TOOLS, INC.
Houston • Los Angeles • New York

Field Housing in Canada

New residential construction in Devon, Alberta.

HOUSING was one of the first of many major problems confronting Imperial Oil Limited early in 1947, when it found itself in possession of a large share of a new oil field at Leduc. It quickly became apparent that a large staff would be required for the development and operation of the company's extensive holdings; but there was no available shelter nearer than Edmonton, 25 miles away, which itself was soon to become overcrowded.

Planning on a scale comparable to the magnitude of the new discovery, a housing subsidiary was organized. This agency, acting on the advice of experts in town planning, purchased an attractive, well-drained tract of 200 acres on the North Saskatchewan River. Construction was started on a new town, appropriately named Devon, after the Devonian lime which is the source of the production in the field. Wide boulevards were laid out with parkways in the center; and utilities were installed at a total cost of approximately $900,000. These included water and gas lines, a sanitary sewer system, storm sewers, graded and gravelled streets, and concrete curbs and sidewalks. Electricity was made available by arrangement with Calgary Power Company.

Residential lots 60 to 65 feet by 150 feet were sold to employes at $50 each; and business lots were sold to reputable merchants at $200 each. Employes were allowed to select their own house plans and to negotiate with a variety of approved builders for construction. Houses were built to conform to standard building practices, considering climatic conditions, etc., and were priced at net cost. exclusive of inspection and supervision and of streets and utilities, with a 10 percent down payment. Purchasers were asked to pay $100 each, which covers about one-fourth the cost of lateral piping from the mains to individual properties.

Mortgages were handled through a large mortgage firm, and guaranteed by the company. Within limitations, purchasers were given free choice of design, decoration, etc., the only major control being a requirement that an employe is not allowed to over-burden himself in mortgage obligations. Monthly payments, which also cover taxes, utilities, and electricity, are kept within 25 percent of montly earnings, in accordance with scientifically-prepared family budgets. Mortgages are planned for amortization over a 15-year period, with interest at 4½ percent.

Business men seeking to purchase sites for retail establishments, including a bank, a hotel, a moving-picture theatre, a filling station, a beauty parlor, clothing and grocery stores, etc., were selected on the basis of ability and experience, preference being given to those who were able and willing to erect structures in keeping with the high standards set for the community. The business district was laid out with the hope that the growing settlement, with its prospects for the future, including low taxes and other features, might in time attract other small industry, including those of a type related to the oil industry, which might contribute to the continuing growth and

■ CONTINUED ON PAGE 218

Redwater

Business section of Devon

Prospecting Licenses and Oil and Gas Leases Covering

Crown Lands in Alberta

RULES and regulations have been promulgated by the Alberta government, under authority of the revised oil and gas laws of that province, to cover all phases of operation. This includes general investigations, detailed examination of lands, acquisition of oil rights, exploratory drilling, and production drilling; and licenses, fees, and bonds required for each step.

GENERAL EXPLORATION: An applicant for such a license is required required to submit a program, or plan of operation; and, upon completion of the program must file a statement of expenditures incurred, maps showing the area covered, and all information concerning the presence of water, coal, and other potentially useful products. The fee for this initial license is only $25; but, if the applicant's place of business is outside the province he is required to post a bond of $1000 to guarantee observance of all regulations.

DETAILED EXPLORATION: No geophysical examination may be conducted anywhere in Alberta without a license, application for which must be supported by an outline of the program of operations. Reports giving details of explorations are an essential feature of all licenses granted by the Department of Mines and Minerals, by means of which it adds to the general store of knowledge pertaining to the geology and natural resources of the province. Such reports are retained on a confidential basis long enough to protect the interests of the parties involved, after which they are added to the archives of the Department.

Order in Council No. 392 of 1949, now effective, provides that the director of Mineral Rights, at Edmonton, may receive applications for the reservation of petroleum and natural gas rights of the Crown, and where representations indicate a satisfactory program of prospecting, a reservation may be made, granting certain priority rights, as to leasing, along with the right to conduct detailed geological, geophysical, and other investigations of an exploratory nature, including drilling of test wells. Each such application must be supported by a fee of $250; and the applicant must post bond at the rate of $2500 for each 20,000 acres, or fraction thereof, accompanied by a report on the geology of the area, if available from published data. Before the termination of the reservation, the holder must furnish to the director maps showing factual data obtained in the geological and geophysical examinations, together with logs and electro-logs of any wells drilled, etc.

No reservations are granted for areas of more than 100,000 acres; and no applicant may hold more than two such reservations at any one time. Reservations may not be assigned in whole or in part; but there is nothing to prevent the applicant from having the work done for him by others. Prospecting rights, or reservations, may be converted into leasehold rights at any time during the term of a reservation; or, where production has been established by drilling, the holder of the reservation must apply for an oil and gas lease within three months of such discovery. The commencement of another well within 4½ miles of such discovery is forbidden until application for lease has been made. There is no limit to the number of oil and gas leases that may be held by any individual or corporation.

The primary term of the reservation is four months, beginning with its "operative date," which is its date of issuance if granted during the first three quarters of any year; or January 1, following, if issued during the final quarter of any calendar year. This special period of grace takes cognizance of adverse weather conditions such as may obtain during winter.

The Department may grant short-term extensions upon the filing of satisfactory reports showing diligence in work done and progress made. Two extensions of four months each may be granted without the payment of rentals, each based on the filing of such reports. Thus, the life of the reservation could extend for one year from its operative date.

Further extensions are possible, but work must be continued in a manner satisfactory to the Department. Rentals, or fees, are collected from the beginning of the second year; but after the first anniversary, extensions are granted on a quarterly basis. Fees are assessed at the rate of 7 cents per acre for each of the first and second quarterly extensions, and at 8 cents per acre during the third and fourth quarterly extension periods. Thus, a reservation may be kept in force during the second year upon payment of fees totalling 30 cents per acre, plus, of course, such costs as may be incurred in the continuing program of work.

Also, assuming the continuance of a satisfactory program of investigation, as determined on the basis of quarterly reports, the reservation may be maintained for a third year, during which actual drilling is required as an added obligation, and rentals are increased to 10 cents per acre for the first quarter, 15 cents for the second, 20 cents for the third, and 25 cents for the fourth, or a total of 70 cents per acre for the third year of the reservation, plus the cost of drilling and other exploratory work.

In the normal course of events, reservations are supposed to be terminated by surrender or by conversion to oil and gas leases by or before the end of the third year; but, open presentation of satisfactory evidence indicating unavoidable delays on account of adverse weather, difficult terrain, physical conditions, or other factors, no fault of the holder, the Department will consider granting further extensions of time, upon such conditions, including penalties, as may be prescribed. The drilling of an exceptionally deep test, for example, is one basis on which further time might be allowed for completion. All such extensions must not exceed a total term of 4½ years.

During the effective life of a reservation, a holder who has fulfilled his program and discharged his work obligations is entitled to apply for and, under present policy, to receive an oil and gas lease good for 21 years, covering checkerboarded lands embracing not more than 50 percent of the acreage in each township, and confined within areas measuring three miles by three miles, or four miles by two miles. Checkerboarding is the aim of the Department, for which reason it is required that tracts not cornering on each other must be

spaced one mile apart. Lands thus excluded from the lease are established as Crown Reserves; and may later be sold at public auction. The lessee, of course, is entitled to bid at such sales. Thus, the government ensures against the bottling up of any particular area.

Fifty percent of the total approved expenditures made on geophysical work and drilling during the term of a reservation may be applied as a credit to the rental accruing during the first year under any lease acquired out of such reservation.

Continued development is required under the provisions of any oil and gas lease. Offset wells must be drilled under conditions as set forth in the Act to protect Crown oil rights from drainage by wells situated on adjacent freehold lands.

Italian Oil Company Plans Modernization of Refineries

The new Italian oil refining company STANIC, jointly owned and operated by Standard Oil Company (N. J.) and the Italian company ANIC, will modernize refineries at Leghorn and Bari, Italy. STANIC's initial capital has been expanded from $35,000 to $21 million. Nominated as managing directors were Victor J. Decorte by the American interests and Dr. Ernesto Santoro by the Italian group.

The Bari plant was closed during the war, but suffered little damage. The Leghorn plant was badly damaged. It has been partly restored and the combined capacity of the two plants is 16,000 barrels daily. They are operated on crude from Middle East sources.

A political dispute has marked Italy's efforts to rehabilitate its petroleum industry. The Italian government announced earlier this year that it would participate financially in all oil companies operating in Italy. The declaration was made in connection with debate on the new Italian mining law now pending. Alexander Miller, a Jersey Standard director then in Italy, said that large-scale prospecting for oil in Italy by U. S. firms would be delayed two years while the new law, if passed, is put into force. He said no new permits for exploration will be issued pending decision on the new legislation.

Meanwhile, the U. S. advised Italy that it favors opportunity for private companies to participate in oil development in Italy. This viewpoint was expressed in connection with possible plans for the development of the Po Valley and Sicilian oil deposits. Minister of Finance Ezio Vanoni has confirmed the existence of large quantities of oil in the Po Valley.

Field Housing in Canada

■ CONTINUED FROM PAGE 216

development of the community.

Residents of Devon townsite voted to incorporate as a self-governing village, effective January 1, 1950, by means of which citizens will take control over their own community affairs, including taxes and, probably, public utilities.

The company realized, also, that space outside the model village would be needed by transient and migratory workmen, such as drilling and construction crews, many of whom make use of house trailers, portable houses, skid-mounted cabins, and tents. Arrangements have been made by a private company to supply trailer-court facilities, including temporary house-and-tent sites.

By the time oil was discovered in larger quantities at Redwater, 19 months later, company officials had learned more about town-planning and residential construction. With a repetition of the same needs in the newer field northwest of Edmonton, officials saw an oportunity to save money for employes by taking competitive bids on a large scale mass-production basis. Contracts were awarded to Bird Construction Company for 80 houses at Redwater and 33 at Devon. Another firm known as Engineered Buildings, Calgary, will have constructed by the end of the current year more than 150 houses in Imperial Oil's housing projects.

By this means, houses can be built for as little as $6.72 per square foot, about two-thirds of the cost of houses designed and built by average builders operating on a small scale. New houses in Calgary, for example, are costing approximately $11 per square foot and are renting for approximately double the monthly payments by means of which residents of Devon and the Redwater Subdivision are acquiring titles to their own homes.

Four general categories of residences are being built at Redwater, in price ranges as follows: $3000-$3500; $3500-$4500; $4500-$7000; and $7000-$10,000.

Under the mass-production plan, an Imperial employe can buy for $4200, for example, a two bed-room house with living room, dining room, porch, and bath, totalling 595 square feet, with a full basement in which are installed a standard gas furnace, thermostatically-controlled hot and cold running water, with recessed bathroom fixtures of the most modern design. Home-buyers are still at liberty to select their own building contractors, providing only that mortgage commitments are kept within safe limits, but such costs run nearly double the mass-production costs.

At Redwater, company officials avoided complications in connection with the disposition of business lots to bidders, as at Devon, by laying out their second housing project as a subdivision of an existing hamlet, as Redwater already had an embryonic business district, with a "municipal" government organized on a basis similar to that of county government in the U. S.

As at Devon, a separate site with all necessary facilities was laid out for the benefit of transient workmen, whose duties will be finished with the end of the drilling campaign.

Under Imperial's financing arrangement, after taking into account the increased value of the lot served with utilities over the price paid by the employe, the downpayment on a $4000 house is only $190, with monthly payments amounting to $30.21. In 15 years the employe will own his own home in a thriving community, with a school, swimming pool, baseball diamond, and other recreational facilities. A workman earning no more than $195 per month can readily handle the purchase of a $4000 home with his monthly payments not exceeding 25 percent of his salary but including heat, light, water, and estimated provisions for taxes.

Consolidated Refineries Israeli Operations Delayed

The present position of the British-owned Consolidated Refineries, Ltd., in Haifa is not clear, due to contradicting statements recently made by Israeli officials. Thus, it was first stated that the Israeli government had repudiated the convention under the terms of which Consolidated Refineries, Ltd., was granted the right to refine oil in Palestine by the mandatory government.

Notifying the company of this decision, the attorney general of the Israeli government wrote that the terms of the agreement were detrimental to the interests of Israel.

However, it was later stated that the Israeli government was willing to negotiate a new contract with the company, and it was suggested that the present delay in the operations of the company's Haifa refinery is not due to nonrenewal of the contract, but that overhauling is continuing and the plant will be ready to operate this month.

It is understood that Consolidated Refineries, Ltd., is prepared to review the terms of the convention, but with the Iraq pipe line still closed, resumption of refining operations is thought by the company to be impractical, though crude oil could be shipped to Haifa by tanker.

BAROCO
"The Work Horse"

PATENT LICENSES, unrestricted as to sources of supply of materials, but on royalty basis, will be granted to responsible oil companies and others desiring to practice the subject matter of any and all of United States Patents Nos. 2,041,086, 2,044,718, 2,064,936, 2,094,316, 2,119,829, 2,294,877, 2,387,694, 2,393,165, 2,393,173, 2,417,307, and further improvements thereof. Applications for licenses should be made to Los Angeles office.

BAROCO has earned its high reputation as a salt-resistant drilling clay. Many operators also use it to prepare or condition muds for other types of drilling. BAROCO has been used successfully for spudding in, for straight drilling, as the base of special-purpose lime-Impermex muds and, in fact, for any type of drilling requiring a good economical drilling fluid. BAROCO takes a lot of punishment from poor mixing waters, from brackish waters in the formation or other contamination without loss of basic good qualities. With Zeogel and Impermex it helps operators drill easily through salt or salt water formations.

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BAROCO will yield 40 barrels of excellent drilling mud per ton of clay in fresh water. Brackish water will cause this yield to decrease only slightly.

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BAROCO and water alone will provide a drilling mud with a 10-cc. water loss and a 2/32" filter cake (A.P.I.).

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BAROCO contains a special clay which is not flocculated by brackish water, or small amounts of salt.

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Tempo Increases in *Alaskan Operations*

THE U. S. Navy will drill four test wells next summer in Northern Alaska's Naval Petroleum Reserve No. 4. Locations have been selected for South Barrow 4, a standby gas well; Simpson 2; Meade 1; and Oumalik 2. Equipment is now moving into the reserve over the frozen terrain between Barrow and the various well sites, and will be rigged up during April and May with drilling operations scheduled to begin in June.

The Navy also will expand its oil exploration program in the reserve and in adjacent regions. A gravity meter crew will continue surveys in the western part of the reserve, thus completing gravity work for the whole plains area. In addition, four full-scale seismograph parties will be at work, two of them in reconnaissance and the detailing of structures in the western portion of the reserve, one in the Smith Bay area, and another in the Fish Creek-Umiat area. Also, eight geological field parties will be employed, assignments for which will be made in the next few weeks. All this exploration is to be carried on by the Navy Oil Unit of the U. S. Geological Survey.

The Navy will have five rigs operating on the reserve by June. At the present time crews are freighting one 1500-foot rig from Barrow to Simpson. Transportation of equipment over the frozen ground is one of the most arduous features of the work. To move the rig from Barrow to Simpson, for instance, will require five trips of the Navy's four giant crawler-tractor trains, each of which is capable of transporting 800 tons at a trip. The Navy is also moving a rig from Barrow to Meade for the first test drilling in that area.

Commodore W. G. Greenman, Director of Naval Petroleum Reserves No. 4, is optimistic about the prospects of finding oil in Alaska. Oil showings have been recorded in nearly all the wells drilled to date, he reports. One of the two wells so far drilled in the Umiat area made 15 barrels a day on initial tests. Cost of the No. 4 Navy reserves project, from the start of exploration activities in 1944 through 1951, will total $42,400,000.

Two tests were drilled on the reserve in 1944. One at Fish Creek went to 7020 feet in the Upper Cretaceous with good showings, but found the sand too fine for quantity production. The second test is still drilling at Oumalik, now down more than 7500 feet, with the Navy prepared to go to 12,000 feet.

Besides these wells, 11 core holes will be drilled before 1950, bringing to 30 the number drilled to date in the reserve. All of the new core drillings will be made in the Simpson oil seeps, and will reach 900 to 1500 feet.

Chief result of the 1949 operations is the proof of faulting in the Simpson area. The structures follow an east-west direction, and it is believed that the reserve's sedimentary basin may reach beyond the southern boundaries and run into the Arctic Ocean. Surface parties next summer will explore outcroppings to the west and to the south of the reserve proper.

While the Navy flies in food to its camps from Fairbanks all year, the main bulk of the supplies and equipment is hauled by water to Barrow in the six weeks that the passage is ice-free every year. In winter, temperatures often reach 30 to 50 degrees below zero, but drilling is continued. The operator faced and overcame terrific difficulties in setting up and maintaining camps in Alaska. Communications have been dependent on plane service, and in 1950, for the first time, helicopters will be used. The radio system is now complete and links Barrow and all the camp sites, well locations and field parties, but frequent magnetic storms black out all radio communications for a week at a time.

The operating group has a current winter personnel of 350 men on the reserve, and this will be increased to 600 for next season's activities. Camp life in Alaska is more severe than on the deserts of the Middle East. The drillers work two shifts of 12 hours each, seven days a week, with two days leave in Fairbanks every two months. The men get five cans of beer and five bottles of "coke" a week, and enjoy some recreational opportunities—a daily movie and a few indoor sports.

Transportation throughout the reserve is a main problem. Barrow and Umiat have air strips from which a plane flies stores to be cached. The pilot marks the route by red flags dropped into the ice. The surface crew travels in a weasel and LVT, an amphibious tracked vehicle. An Eskimo is usually employed as guide. The party then follows the route of the red flags dropped from the plane as it marks out a more precise route over ice sufficiently strong to support the motorized trains which are to follow.

The train itself consists of five or more crawler-type tractors, each hauling several of the great 16 to 20-ton sledges. The first tractor in the train has a snow plow. One of the sledges has on it a hut in which the crew members sleep, and another serves as a portable kitchen. These trains—essentially self-contained units—may be gone for three weeks at a time, covering 20 to 70 miles a day.

Mud is another of the great obstacles to all kinds of work in Alaska. In the spring thawing season, surface frost melts to a depth of two or three feet, resulting in a mud bog through which few surface vehicles can travel.

While the Navy is making no predictions about Alaska, industry officials who have visited the spot believe Petroleum Reserve No. 4 may ultimately produce 100,000 barrels a day from a reserve of perhaps as much as 500 million barrels.

Roumanian Production Fails To Reach Planned Levels

Roumania's petroleum industry has failed to fulfill its plan for the first half of 1949, a Roumanian cabinet statement discloses. Roumania is regarded as highly strategic in the oil economy of the "iron curtain" countries since it supplies petroleum to both the Soviet Union and the Soviet satellites of Eastern Europe.

Both crude oil output and refinery throughput were below planned levels, it is admitted. Report on the state plan said the natural gas output had exceeded quota by 30 percent.

Proposed Oil Law Revisions Will Aid Operators in Peru

ADMINISTRATION leaders in Peru have indicated a strong possibility that Peru's long-awaited new petroleum law may be passed shortly. A three-man commission appointed September 15 to draft the law was expected to make its report and submit a final draft before the end of the year.

The statement was made by President Manuel Odria, head of the military junta, on October 26, the first anniversary of the Arequipa revolt. Passage of a new petroleum law would break a three-year deadlock during which rival political factions have each blocked attempts of the other to take action. New legislation is to replace the out-moded basic laws of 1922 under which the industry operates in a restricted fashion, finding itself unable to expand into the interior areas which include the upper headwaters of the Amazon basin.

Hopes that the statutes will be passed are strengthened by the changing tenor of the Peruvian press. Much of the past resistance to foreign oil capital is being replaced by an apparent readiness to accept participation of outside interests in the development of oil resources. President Odria has been supporting such a move since the beginning of his regime.

Recent decrees have served to nullify former supreme decres by which the Empresa Petrolera Fiscal, government oil agency, was formed early in 1948. The EPF has been reorganized so that it no longer is an autonomous agency, and has been placed under the jurisdiction of the Ministry of Development and Public Works. Its director will be responsible to the newly-appointed Director of Petroleum, Artidoro Alvarado Garrido, who is said to see the necessity of a reorganization of the country's petroleum economy.

The need for prompt action is indicated by the increasing difficulties facing companies now operating under the current law. International Petroleum Company, Peru's largest operator, is faced with a decrease in crude production and an increase in domestic consumption which the company is obligated to fill at strictly regulated prices. International's production has declined from a peak of 40,000 barrels daily in 1937 to about 32,000 barrels daily in recent months. At the same time domestic requirements have risen from 8500 barrels daily in 1937 to 19,500 barrels a day this year. Of this consumption, International must provide about 95 percent. All producing companies under the present law are required to furnish a percentage of their total production toward filling Peru's domestic needs.

The narrowing of the export margin is felt by producers since profits can only be realized on exportable surplus. During the period from 1937 to date exports have dropped from 33,000 barrels daily to a current 18,000 barrels. At the same time International has been unable to secure permission to shift its domestic obligations to other producing companies.

There also has been difficulty with dollar exchange, and companies have been unable to retain 100 percent of dollar profit from exports. Meanwhile, International has reduced the number of drilling rigs operating, but is retaining field personnel in the hope that more favorable operating conditions will develop.

Recently there has been renewed interest in the possibilities of the Montaña region east of the Andes with news of an oil discovery by Compañía Peruana de Petróleo el Oriente operating in the Pisqui River area.

The chief terms of the pending legislation are more attractive than were previously offered. While they may be subjected to changes by the time the law is finally passed, the terms are substantially as hoped for, and will include the following:

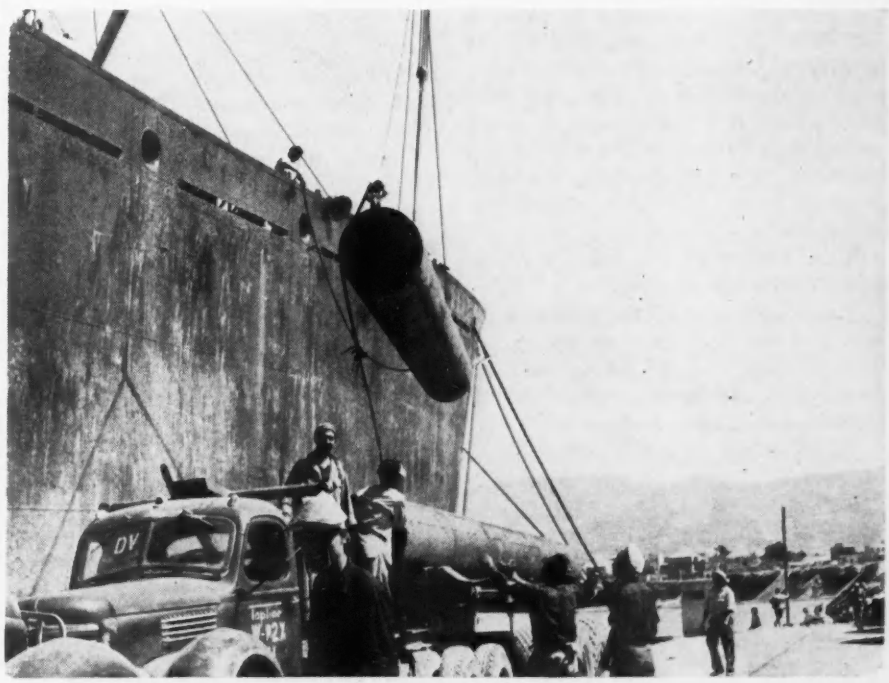
1. Exploration concessions will be open for application throughout Peru, without the previous restrictions by areas.

2. A staggered royalty scale is proposed, rate of which depends on distance from shipping points. It will vary from as high as 12½ percent of production for the coastal areas, to 6 percent from the mountain regions, and 3 percent from jungle areas.

3. No oil export taxes are to be imposed by the Peruvian government.

4. Foreign operators will be allowed to retain all of the foreign exchange derived from exports.

Among other things the law is expected to clear the way for granting a petroleum concession on the Sechura Desert area, on Peru's coastline just south of International's producing properties at Talara. It is likely that this will go to International, which had already entered into a contract with the government, but was awaiting congressional ratification of the agreement.



THE TRANS-ARABIAN PIPE LINE COMPANY has received its first shipment of 30-31-inch pipe for the western end of the line at Beirut, Lebanon. Shown are sections of the 30-inch pipe nested within the 31-inch being unloaded from the S.S. William Glackens. Following unloading, TAPline's pipe is trucked to Sidon, south of Beirut, where construction of the western end of the line is under way.

Argentina Explores for Oil at Southern Tip of Continent

The Argentine government through its official agency, Yacimientos Petroliferos Fiscales Argentinos, is carrying on an ambitious program designed to develop one or more new oil fields in Tierra del Fuego at the southernmost tip of the South American continent. Eyeing the efforts of the Chilean oil monopoly, Argentine geologists and engineers have undertaken an extensive exploration program and have moved in heavy equipment. According to official sources, YPF is prepared to conduct a thorough search for oil and has set up extensive installations and equipment designed to operate under severe cold-weather conditions.

Argentina, through YPF, ordered extensive geological reconnaissance work in the Tierra del Fuego area in 1937 and reported excellent possibilities. The country was on the point of embarking on an ambitious program when the war in Europe intervened and operations were suspended. Geophysical equipment which had been used in Tierra del Fuego was returned to other areas in Argentina and it was not until 1946 that geophysical work was resumed.

Field data assembled indicate extensive oil reserves may exist in this most southern tip of Argentina, and by 1948 YPF had already worked out a preliminary drilling program which went into effect early in 1949. YPF officials have set up a program so that operations may continue over a period of years in the event current developments warrant such an extensive program.

Operations in the Tierra del Fuego area have been assigned to the administration of the Comodoro Rivadavia area and this division has completed selection of the camp site and has built necessary housing units and auxiliary installations.

The camp is about five miles from Rio Grande and about four miles from La Mision anchorage. It is well placed with respect to the nearby town of Rio Grande, the port, and the first two staked locations, TF-1, about nine miles northwest, and TF-2, 3½ miles to the south. The camp is well protected against prevalent South Atlantic winds, and is surrounded by sufficient acreage and has an abundant water supply.

YPF has provided dormitories, messhalls, recreation center, and medical facilities for the personnel. The working area is well equipped with utility shops, warehouses, garages, radio communication system, and field offices.

The responsibility of supervising and coordinating the over-all program is in the hands of a chief engineer, who is assisted by an executive chief clerk, two drilling supervisors, a geologist, an assistant geologist, a mud engineer, and members of the clerical and departmental staff.

The drilling equipment consists of 136-foot derricks, provided with substructure of 450 tons capacity, two rigs, each equipped with 4½-inch drill pipe, and capable of drilling to 12,500 feet. Motive power is provided by diesel motors capable of 525 horsepower at 900 revolutions per minute. The rigs are also provided with two 7¾ x 16-inch mud pumps, one of which is a standby.

The mud circulating system is provided with vibrating shale shakers and a specially designed heating system in order to prevent congealing of the mud during the winter months. The fuel storage to supply the rigs and auxiliary installations consists of five tanks with an over-all capacity of 4650 barrels.

Alberta's Golden Spike Field Given Its Second Producer

The Golden Spike field in Alberta, Canada, has its second producer with completion of Imperial Oil Limited's Golden Spike 4, about three-quarters of a mile northeast of the discovery. The new well was completed at 5965 feet after having established a 560-foot section of Devonian D3 pay zone, 16 feet more than was found in the discovery, and produced at 2712 barrels daily before acidization.

Golden Spike was thought to be one of Canada's greatest discoveries at the time the discovery well drilled the thick pay section and then tested for a potential of 12,000 barrels daily after treatment with acid. However, failure of two extensive step-outs limited the size somewhat, and although its area is yet to be determined, it is not thought now that it will cover more than a square mile. However, reservoir data would indicate a large reserve per unit of area, and estimates place reserve at around 50 million barrels if the field covers no more than a square mile.

Experience thus far has indicated that the area has less reservoir energy and less porosity than the Leduc field, and that yield will be somewhat less per acre-foot than from Leduc.

Imperial Oil recently added another discovery to its record in Alberta by opening a new field at Excelsior, 12 miles north of Edmonton and about five miles southwest of Bon Accord. Drilled to 4125 feet, the test failed to find production in the D3 horizon, but was completed flowing at the rate of 792 barrels a day from D2 pay. Imperial, which originally held a substantial block of acreage in the vicinity of the well, has farmed out several block to independent operators who will shortly start outpost tests to the southwest of the discovery.

World Oil Index
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The complete editorial index covering all issues of WORLD OIL published during 1949 has been prepared and is bound separately in convenient pamphlet form. It will be sent free to all subscribers who write requesting copies.

Orders should be addressed immediately to the Circulation Department, Box 2608, Houston 1, Texas, as quantities are limited.

Phillips Spending $10 Million In Eastern Venezuela Activity

F. W. Floyd, general manager of Phillips Venezuelan Oil Company, who was recently interviewed by the Venezuelan press told reporters there that his company is spending approximately $10 million in exploration and drilling operations in Eastern Venezuela.

Phillips' Venezuela production is now 7000 barrels daily, and of this total more than 5000 barrels a day are produced by the recently discovered San Roque oil field, about 13 miles south of Aragua de Barcelona, State of Anzoategui.

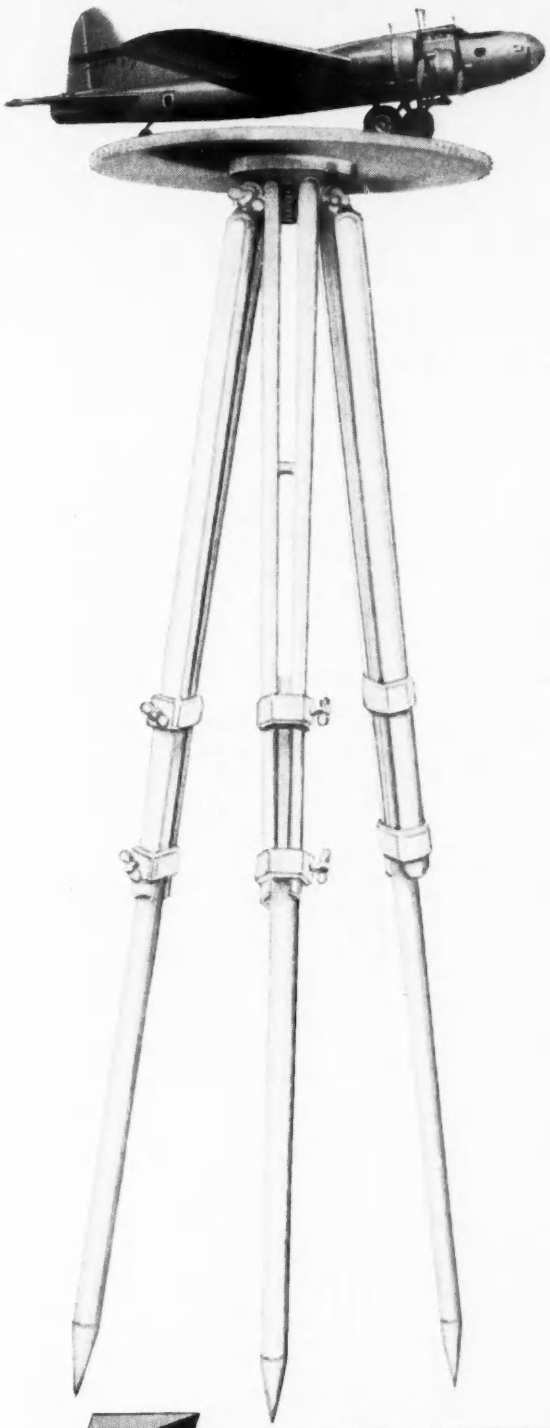
The San Roque crude is of paraffinic base (39-47 API) and is of the same excellent quality produced in the San Joaquin field of Creole and Mene Grande. San Roque is not far distant from San Joaquin-Anaco-and-El Roble.

During 1946-48 Phillips spent more than $5 million exploring and drilling its concessions in the state of Guarico, Central Venezuela. Twelve wildcats were drilled in this region by Phillips and all were dry holes. Some were completed as water wells and were turned over to the regional authorities to supply the water demand of part of the population of that region.

At present Phillips is drilling six wells in San Roque, some as deep as 9000 feet. At this time the true daily potential of the San Roque field cannot be evaluated, but company executives are optimistic.

30,000 FOOT TRIPOD

for a 100 square mile view



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Whether you need reconnaissance mapping from 30,000 feet —or detailed mapping for engineering planning, AERO has the right plane for *your* work . . . DC-3s for large aerial surveys . . . the amphibian PBY for projects in very remote areas . . . and smaller planes for lowest-cost operations on domestic assignments.

Moreover, AERO brings to bear on your mapping problems the worldwide experience of a team of highly skilled men— our photogrammetric engineers whose solid knowledge of aerial mapping is especially valuable in your early planning; our project engineers who keep operations humming in the field; and our expert technicians at AERO's home plant who work in close liaison with our field staff and your engineers to collect precise map data quickly and economically.

AERO has mapped for the oil industry in Canada, the United States, the Caribbean, Central and South America and Africa. A consultation with AERO engineers regarding your mapping requirements can bring important economies in time and money to your company. Write Aero Service today.

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Success Promised in First Foreign Venture by CIMA

Mexican American Independent Company (CIMA) has been virtually assured of success in its first foreign venture with indications that it will obtain production in a well now being drilled in the region of the Isthmus of Tehuantepec, Mexico.

The well, Tortuguero 1, on the north shore of the Isthmus, on the beach just east of the town of Coatzacoalcos, was drilling ahead at 4662 feet early in December after having found a 12-foot oil sand at 4052 feet from which it flowed 48 barrels hourly through one-fourth-inch choke during a drill-stem test. The well is scheduled to 5500 feet, or salt expected within that range.

Although the well is on land, it is testing an offshore structure through directional drilling, the structure having been calculated to be a salt dome according to geophysical information. At the point where the oil sand was tested the well had been drilled 3330 feet vertically and 2165 feet horizontally.

The operating company, drilling under a special contract with Petroleos Mexicanos, is composed of American Independent Oil Company, 53⅓ percent; Signal Oil & Gas Company, 33⅓ percent; and Edwin W. Pauley, 13⅓ percent. American Independent Company is a group of American independents joined for foreign exploration. The Tortuguero well is the first actual drilling operation in which the company has been interested, although it has since spudded in a wildcat in the Kuwait Neutral Zone where it holds a concession jointly with Pacific Western Oil Company.

The well in the neutral zone was spudded December 12, 1949, and is unique in that it is about 20 miles inland from the Persian Gulf shore, while the operating base, including warehouse, offices and living quarters for the staff, is afloat. The company is using a converted Navy LST as a base of operations.

Venezuela Production Gains After Slump Early in Year

Venezuela's crude output was making sharp gains toward the end of the year following a depressed period in the early months.

After having produced a record volume of crude during 1948, the supply situation toward the end of the year, coupled with a soft market for heavy fuels, forced cutbacks in production. Starting with a daily average production of 1,245,000 barrels in January, 1949, the output reached a low of 1,155,476 barrels daily in March, from which point it again started to climb. By September the daily output had passed 1,425,000 barrels monthly, and in October, the latest month for which complete figures were available, Venezuela was producing at a rate of 1,431,000 barrels daily, and preliminary figures for the first weeks of November indicate that the average for that month will probably reach 1,443,000 barrels a day. Throughout the past three months production was maintained at the highest rates in Venezuela's history. A continuation of such rates will bring total output for the year to a point very near the 1948 record.

Each of the three largest contributors to the nation's output, Creole Petroleum Corporation, the Shell Group and Mene Grande Oil Company, have had a substantial share in the increase. Creole, which started the year producing 577,948 barrels daily and reached a low in March at 530,128 barrels a day, was producing 684,064 barrels a day in October. Shell, which produced 375,836 barrels a day in March, was up to 426,449 barrels daily in October and had averaged 402,712 barrels daily for the first ten months of the year. Mene Grande built its production back up to 192,211 barrels a day in October after a low of 145,545 barrels daily in March.

Emsland Continues as Most Promising Area in Germany

The Emsland area of Western Germany continues as the most promising region of the nation as a new discovery is reported at Scheerhorn. C. Deilmann Bergbau et al's Suderbruch 1, about two miles north of the Georgsdorf field and the same distance southwest of Adorf, has found the normal Emsland horizon, the Bentheim sandstone at 3670 feet. First tests indicated a production of a little more than 500 barrels daily.

Of particular interest in this area is that the Scheerhorn oil is from a stratigraphic trap, a shoreline feature of a type not found heretofore in the Emsland area.

Meanwhile, official crude oil production figures covering western Germany and Baden indicated a production for September of 522,400 barrels, or 17,417 barrels daily. This was the highest daily yield achieved by Germany since 1942 and brought output for the first three quarters of 1949 to 4,256,000 barrels, or one-third more than was produced during the same period in 1948. The principal part of this increase was contributed by the Emsland fields which nearly doubled their rate of output during 1949. The fields in other districts of Northwestern Germany succeeded in maintaining their production rates at the same level or higher than in 1948.

Preliminary reports indicated production during October would go even higher, reaching a total of 542,000 barrels as both Emsland and Hanover fields showed increases.

Drilling activity continued to increase and late in the year it seemed likely that the goal set at the beginning of the year would be reached if not surpassed. To the end of September more than 715,000 feet of hole had been drilled in 1949, more than double the amount drilled during the same period in 1948. That the activity was widespread was indicated by the fact that seven of the operators had drilled 65,000 feet or more.

Russia Claims Baku Field Is Growing in Prominence

A new field in the Baku district is becoming a prominent source of crude oil, it is indicated by the Russian press.

This area, referred to as the Busovny field, is northeast of the town of Baku on the Apsheron Peninsula. It was brought into production during World War II, and already had begun to occupy a prominent position in the production of the region by 1946. The Soviet press, which usually gives full credit to industrial achievements, although usually in a roundabout manner, hardly mentions any progress in the old historical producing areas of the Peninsula, but speaks with satisfaction of the development of the Busovny field. Although no concrete production figures have been published, it has been estimated that it is now producing about 7 million barrels yearly. It is still uncertain whether the rising production from this new area will be able to balance the decline of the older fields. In 1939, the fields on the Apsheron Peninsula produced approximately 154 million barrels of oil, according to some reports, while it is claimed that it produced no more than about 90 million barrels in 1945. The fourth Five-Year Plan which ends with 1950 anticipates a yield of about 119 million barrels from the area.

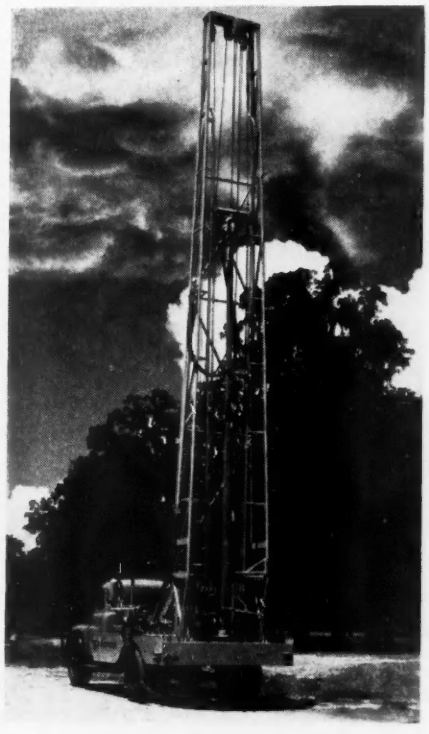
Scattered press reports would indicate some degree of importance attached to the new Busovny area. A new trust, the Busovneft, was formed, and its geologists, B. K. Bavasade and S. I. Dshafarow, were reported as having received the Stalin prize in 1947. Several deeper horizons were opened during 1946 and 1947, and reports in the press state that not only has the field repeatedly surpassed its production goals, but praise has been given to drilling personnel for setting records of footage drilled.

NEW AND IMPROVED EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

1—Drill

This item supplements Careys Machine Company data as shown on page 1023 of Composite Catalog, 17th Edition.



A new drill for shot-hole, core-hole and water-well drilling is rated at 1500 feet. Operated by one dual-control lever, the drawworks has two drums, four speeds, and is driven by 13-inch Twin Disc plate friction clutches. The heavy-duty, oil-bath type rotary table has timken bearings, and is equipped with a four-speed heavy-duty transmission.

The Speed-Hole drill mast is fitted with two hydraulic cylinders for raising and lowering. The unit has a built-in check valve. Either a 22- or a 32-foot mast above the rotary is available.

For additional information, write Careys Machine Company, 1702 Roberts Street, Houston, Texas, *referring to* WORLD OIL *item* 1.

2—Sump Pump

This item supplements McFarland Manufacturing Corporation data as shown on pages 3254-3255 of Composite Catalog.

A high-pressure sump pump for restoration of gasoline and lubricating oils to high pressure transmission lines is designed to handle any pipe line fluid.

Operating on a power differential principle, the pump requires no prime mover. It develops a high discharge pressure in direct ratio to low input pressure. Both exhaust and high pressure discharge are connected to the same line.

The pump will operate in any position and is adaptable to installations requiring special mounting or where space is limited.

For additional information, write McFarland Manufacturing Corporation, 1630 Roberts Street, Houston, Texas, *referring to* WORLD OIL *item* 2.

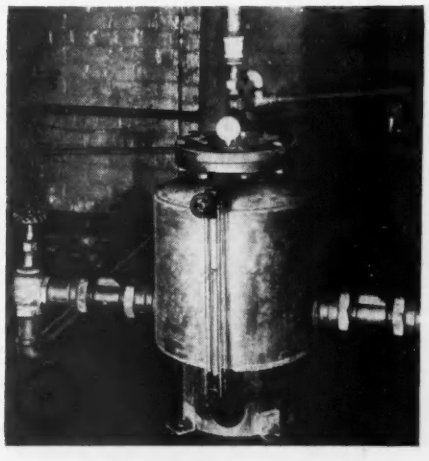
3—Cycling Jet Pump

This item supplements Penberthy Injector Company data as shown on pages 4090-4095 of Composite Catalog, 17th Edition.

A two-part cycle, which is automatically continued until the pump is turned off, enables a new cycling jet pump to lift by suction and discharge against heads approximately equal to the gas, air or steam pressure used.

This pump consists of a receiver tank, float-controlled operating valve, ejector and necessary piping, gauges and valves. Gas, steam or air under pressure is used for operation. Other than the float-controlled operating valve and two check valves there are no moving parts.

When the pump is turned on with the receiver empty, the float is in the lowest position. The gas, steam or air is directed into the ejector, creating a vacuum in the receiver. Liquid to be pumped is thus drawn into the receiver. As the receiver fills, the float rises, ultimately closing the control valve to divert gas pressure from the ejector to

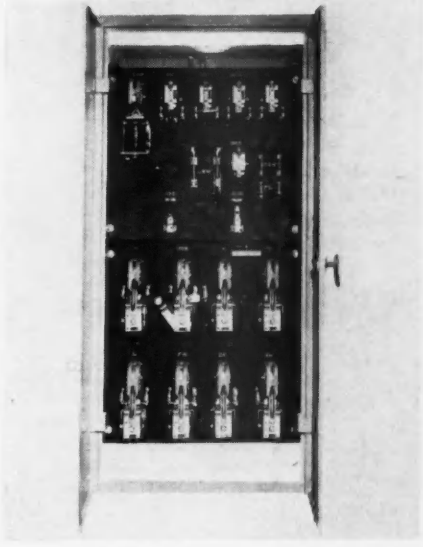


the receiver. This reverses pressure in the receiver, creating a positive pressure instead of a vacuum. The check valve in the inlet closes and the check valve in the outlet opens. Gas pressure now forces the liquid out of the receiver. When the receiver is empty, the float again actuates the ejector, starting a new cycle.

For additional information, write Penberthy Injector Company, 1242 Holden Avenue, Detroit 2, Mich., *referring to* WORLD OIL *item* 3.

4—Crane Hoist Control

This item supplements General Electric Company Apparatus department data as shown on pages 1809-1820 of Composite Catalog, 17th Edition.



A new direct-current crane hoist control provides power hoisting and power dynamic lowering, depending upon the requirements of the load on the hook. The change from power to dynamic braking lowering is inherent in the control and hence is independent of either the operator or any particular control device. When decelerating the speed is reduced automatically before the solenoid brake sets.

When the master switch is thrown rapidly from the OFF position to any lowering position, with a load on the hook, the motor speed does not overshoot. Since the first hoisting point will hold rated load with no downward drift, the master switch need only to be moved to the second hoisting point to lift the load.

A spring-closed contactor provides dynamic braking circuit and retards lowering speed if the magnet brake fails to hold an excessive load. A metal-clad enclosure protects the panel against dirt and dust.

For additional information, write General Electric Company Apparatus department, Schenectady 5, N. Y., *referring to* WORLD OIL *item* 4.

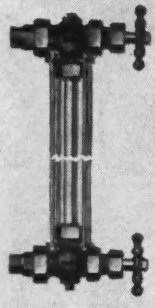
PENBERTHY
Liquid Level GAGES

REFLEX

Reflex type complete with gage valves. Liquid shows black—empty space shows white. Liquid level is always unmistakable.

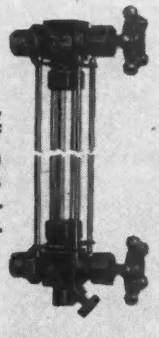
TRANSPARENT

Transparent type complete with gage valves. Used where through vision is desired under high pressures and/or temperatures.



DROP FORGED STEEL

Tubular glass type, Chrome-Moly temperature resisting steel body, stainless steel trim, regrinding removable seats.



ALL IRON

Tubular glass type, extra heavy body of special high strength alloy iron, shanks alloy steel, trim stainless steel, valves self-cleaning.

There is a Penberthy Gage of superior quality for every liquid level gage requirement. Gages are fabricated to customer's specifications from special alloys to meet unusual corrosive and temperature conditions. All Penberthy Gages conform with API-ASME requirements.

3277-B

PENBERTHY PRODUCTS

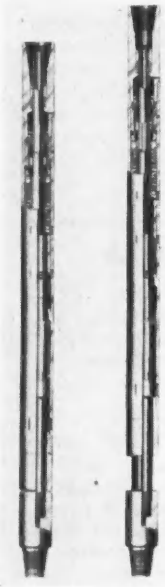
PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant — Windsor, Ontario

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

5—Adjustable Jar

This item supplements Shaffer Tool Works data as shown on pages 4433-4496 of Composite Catalog, 17th Edition.



The tripping mechanism in a new straight-pull adjustable jar uses a flat-disc spring unit that permits the jar to function with equal efficiency in mud, oil or sand.

The jar incorporates a positive screw-type adjustment that allows an increase of only approximately five tons per adjustment, thus eliminating the danger of accidentally adjusting the tool so high that the jar cannot be tripped.

The jar strikes its blow by direct raising and lowering of the drill string. It is not necessary to place torque in the drill string to trip the tool.

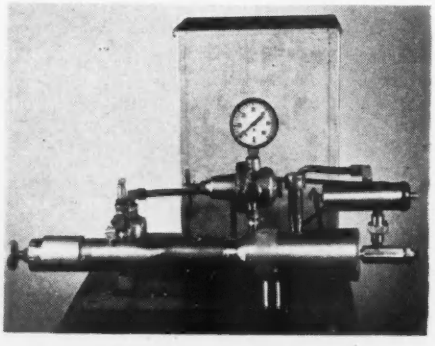
For additional information write for Bulletin 58, Shaffer Tool Works, Brea, Calif., *referring to* WORLD OIL *item* 5.

6—Chemical Injector

This item supplements McFarland Manufacturing Company data as shown on pages 3254-3255 of Composite Catalog, 17th Edition.

Two ounces to 20 gallons of light or heavy fluids can be injected in a 24-hour period with a new chemical injection pump. Speed range of the pump is from 5 to 150 strokes per minute with a normal operating speed of 60 strokes per minute. Operating pressure range is from 0 to 60 pounds per square inch, with normal operating pressure 30 psi.

The main piston and valve are the only two moving parts. The pump has a positive one inch stroke which provides constant injection of fluid. The injector is 24 inches long, five inches wide, and 12 inches high. It is equipped with or without a five-gallon capacity stainless steel chemical tank.



The pump has a 2½-inch main cylinder and a 1¼-inch return cylinder. Standard pump has a 3/16-inch plunger with a ratio of 140:1. Accessories include a ¼-inch Norgren air regulator with gauge and a McFarland positive sight feed.

For additional information, write McFarland Manufacturing Company, 1630 Roberts Street, Houston, *referring to* WORLD OIL *item* 6.

7—Floodlights

This item supplements General Electric Company Apparatus department data as shown on pages 1809-1820 of Composite Catalog, 17th Edition.

Two new heavy-duty, general-purpose floodlights, Type L-84 rated at 500 watts and the Type L-85 rated 1000 watts, can be used for either general

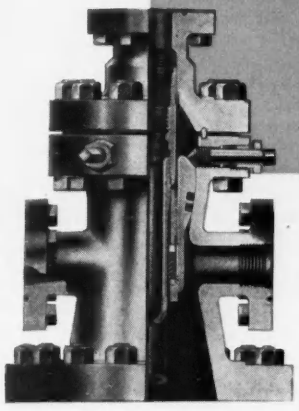
lighting service or floodlighting service lamps.

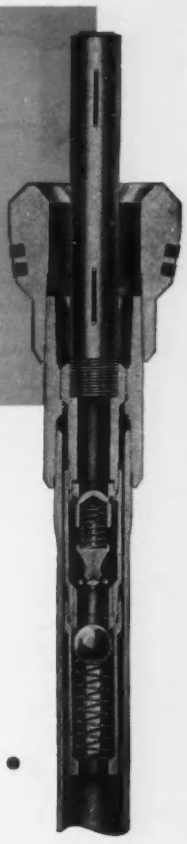
Constructed of aluminum, the new units weigh less than 17 pounds. The hinged door has three swing-type door latches to open it for servicing. The heat-resistant door glass is cushioned in a silicone rubber gasket which seals the joints between the door and the casing. A clamping handle for vertical adjustments is provided.

An auxiliary reflector of finished aluminum is provided. Both narrow-beam polished or wide-beam etched reflectors are available.

For additional information, write for Bulletin GEC-537, General Electric Company Apparatus department, Schenectady 5, N. Y., *referring to* WORLD OIL *item* 7.

GRAY SYSTEMS OF WELL CONTROL INCLUDE THESE DEVELOPMENTS





PATENT NUMBERS 2,241,288 AND 2,148,327

RELATED PATENTS INCLUDE NUMBERS:

2,103,431	2,162,179	2,150,887
2,157,964	2,358,677	2,241,333
2,148,360		2,442,548

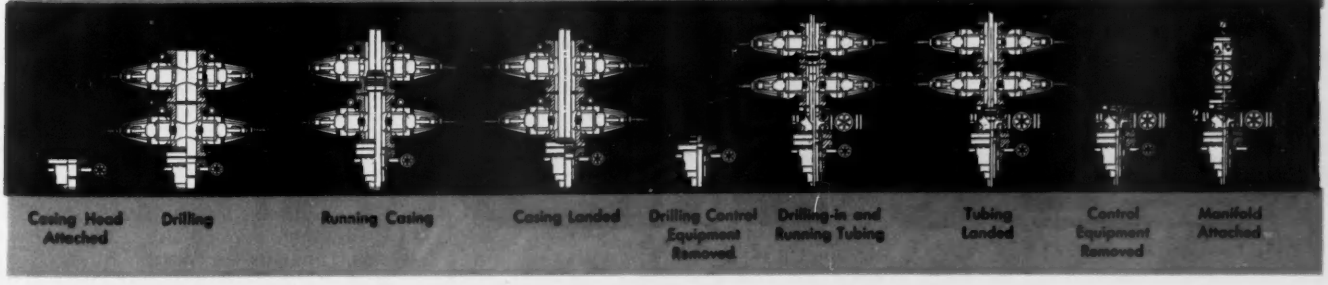
This simple combination of tubing head and tubing hanger provides complete control both of the annulus between casing and tubing and through the tubing during the performance of completion operations.

THE WHOLE IS THE SUM OF ITS PARTS

These parts, like other Gray equipment, are parts of a complete, coordinated system of well control. This system is designed to fulfill two specific functions: 1) to provide temporary seals for control until permanent seals are affected and 2) to allow for the removal of each part as soon as it completes its operating function, and thus to eliminate the operating hazards connected with its use.

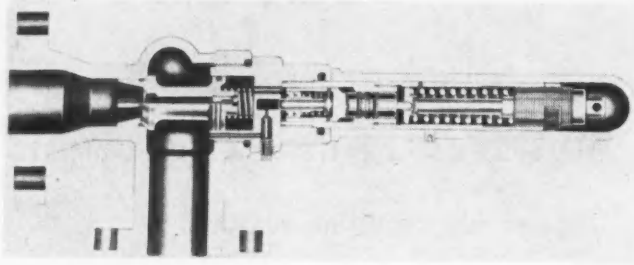
GRAY TOOL COMPANY
HOUSTON

Rocky Mountain Representative: CARL MOULDEN, P. O. Box 1890, Casper, Wyoming



8—Pressure Operated Relief Valve

This item supplements Garrett Oil Tools, Inc., data as shown on pages 1745-1768 of Composite Catalog, 17th Edition.



Type "A" of two new pressure operated relief valves is designed principally for hydraulic services such as use on crude and product lines and systems where long blowdown is usually desirable.

The valve utilizes line pressure to open and close the main plunger. Snap-acting controls assure the main plunger being in full open or fully closed position at all times. Movement of the plunger to either position is pressure-cushioned to prevent shock, hammering and severe metal-to-metal impact.

Bodies of the valves are cast steel, with inconel and monel trim.

For additional information, write Garrett Oil Tools, Inc., P. O. Box 6115, Houston 6, *referring to* WORLD OIL *item* 8.

9—Lift-Plug Valve

This item supplements Cameron Iron Works, Inc., data as shown on pages 1025-1092 of Composite Catalog, 17th Edition.

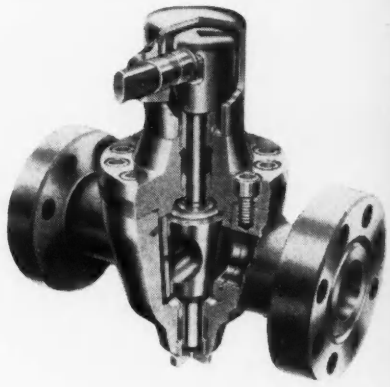
A new non-lubricating lift-plug valve combines the characteristics of plug, gate and globe valves.

Need for lubrication is eliminated. A complete seal is effected when the valve is shut because a portion of the exterior surface of the removable seat is exposed to pressure, thus permitting a pressure sealing action. The plug is lifted straight away from the seat before rotation to prevent scoring or galling of the seating surfaces.

Since the seat is a separate piece, both seat and plug may be replaced in the field. Seat and plug are furnished in corrosion-resistant materials.

Plug and seat, bonnet, cam, camshaft, and cam housing are drop forgings.

For additional information, write



Cameron Iron Works, Inc., P. O. Box 1212, Houston, *referring to* WORLD OIL *item* 9.

EACH WAY-EVERY DAY
DAILY Flights to
VENEZUELA
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JAMAICA!

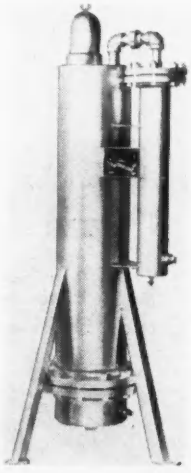
Chicago & Southern Air Lines' fleet of 4-motored Douglas Skymasters now offers seven-days-a-week service through the Houston and New Orleans gateways to Caracas, Kingston, and Havana. Flights each way every day provide one-plane service from the Great Lakes to the Venezuelan oil capital. Ask your travel agent or nearest C&S ticket office.

CHICAGO & SOUTHERN AIR LINES
General Offices, Memphis, Tenn., U.S.A.

C★S

10—Dehydrator

This item supplements Empire Machinery Company, Ltd., data as shown on page 1431 of Composite Catalog, 17th Edition.



A 495-pound unit, the Empire Compressed Air Dehydrator, dehydrates and filters compressed air before it reaches air controls of mechanisms. Two pounds of white waste pack in the oil absorbing tank filter oil from the compressed air, and a 100-pound bed of chemical crystals removes moisture from the air.

Screens on the outlet side of the oil absorbing tank stop white waste particles that might otherwise go into the dehydrant. The chemical crystals are kept out of the air system by a similar screen.

The dehydrator operates at greatest efficiency at 50 cubic feet per minute flow, and 125 pounds per square inch working pressure.

For additional information, write Empire Machinery Company, Ltd., Odessa, Texas, *referring to* WORLD OIL *item* 10.

Standardize on Standard

9 BIG STORES
CONVENIENTLY LOCATED

STANDARD pioneered in servicing the oil industry in the Gulf Coast. 9 big stores, completely stocked with the finest drilling and production equipment, are strategically located with respect to the active fields in this area . . .

Now comes the development of "off shore" Marine Drilling and you will find STANDARD on the ground, offering the same service that has earned the good will of operators throughout the entire Gulf Coast territory . . .

Houston has been selected as the location of our 9th branch store. Here you will find the most complete stock of drilling and production equipment and here you will receive the same co-operation and assistance in your production problems that have always characterized STANDARD service.

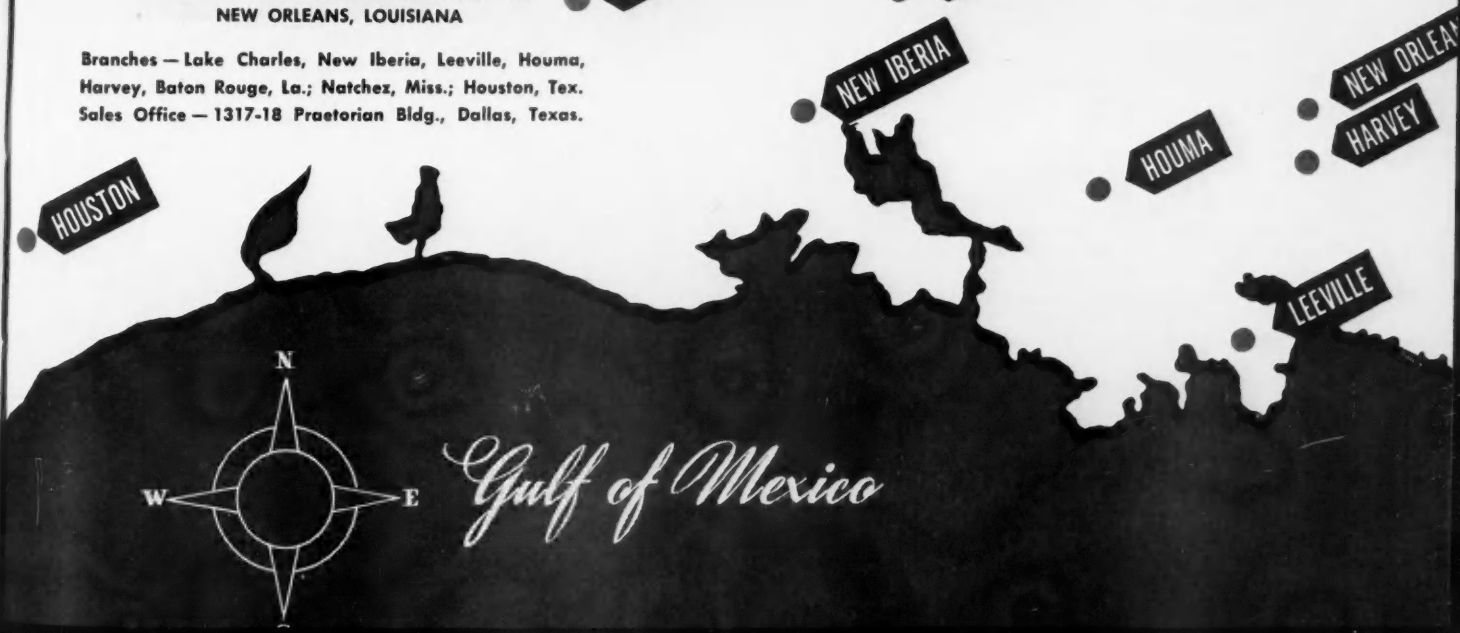
DISTRIBUTING THE PRODUCTS OF THESE LEADING MANUFACTURERS:

National Tube Co.
Republic Steel Corp.
Hughes Tool Co.
Reed Roller Bit Co.
Cameron Iron Works
Wickwire Spencer Steel Co.
Whitlock Cordage Co.
The Lunkenheimer Co.
Edward Valve & Mfg. Co.
Hewitt Rubber Corp.
Mission Mfg. Co.
Stockham Valves & Fittings, Inc.
Web Wilson Oil Tools
Link-Belt Co.
Nordstrom Valve Co.
National Transit Pump & Machine Co.
Taylor Forge & Pipe Works
Phelan Faust Paint Co.
Rust-Oleum Corp.
Hancock Valves
Ashcroft Gauges
Gates Rubber Co.
Worthington Pump & Machinery Co.
and others

Standard

SUPPLY AND HARDWARE COMPANY
NEW ORLEANS, LOUISIANA

Branches — Lake Charles, New Iberia, Leeville, Houma, Harvey, Baton Rouge, La.; Natchez, Miss.; Houston, Tex.
Sales Office — 1317-18 Praetorian Bldg., Dallas, Texas.



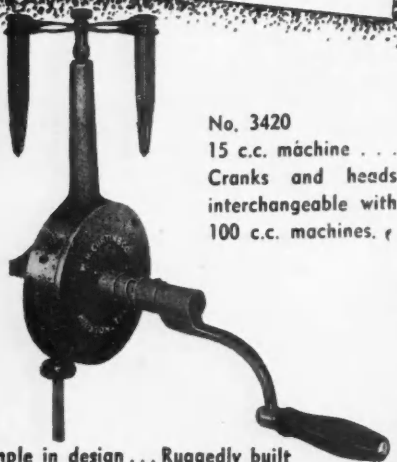
PETROLEUM ENGINEERS
CABLE & STINE
WICHITA FALLS, TEXAS

EXPERIENCED PRACTICAL
AND TECHNICAL CONSULTING
PRODUCTION ENGINEERING
SERVICE

•

SPECIALIZING
in
MODERN
SECONDARY
RECOVERY

QUICK, ACCURATE RESULTS
LESS EFFORT
Curtin CENTRIFUGES



No. 3420
15 c.c. machine . . .
Cranks and heads
interchangeable with
100 c.c. machines.

Simple in design . . . Ruggedly built . . . Requires no special care . . . Great Ratio and throw of crank produce required speed with no strain. Curtin Centrifuges meet all *A.S.T.M. Standard Method D-96* and *A.P.I. Code No. 25* requirements. Fully descriptive literature upon request.

W·H·CURTIN & CO.

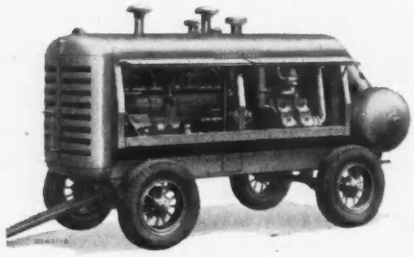
HOUSTON . . . NEW ORLEANS.

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

11—Compressor

This item supplements Ingersoll-Rand Company data as shown on pages 2465-2472 of Composite Catalog, 17th Edition.



Full diesel-engine drive powers the Mobil-Air IKA-500, a new portable 500 cubic feet per minute compressor. The International Harvester heavy-duty UD-24 starts as a low-compression gasoline engine and after a short warmup period is shifted to full diesel operation.

The Floating-Speed regulator slows down the compressor to the lowest practical working speed that compresses just enough air to hold the pressure. Full capacity is delivered at rated 100 pounds per square inch pressure.

For additional information, write Ingersoll-Rand Company, 11 Broadway, New York 4 N. Y., *referring to* WORLD OIL *item* 11.

12—Weighting Material

This item supplements Oil Base, Inc., data as shown on pages 3629-3636 of Composite Catalog, 17th Edition.

Pure ground barytes is used in a new weighting material for drilling muds, OB Hevywate. The white chemical assays between 4.26 and 4.41 specific gravity, which leaves practically no room for foreign matter in the material.

The material is ground 99 percent through 325 mesh. It contains no water solubles, and no contaminants to adversely affect drilling muds to which it is added. It is sacked 100 pounds net.

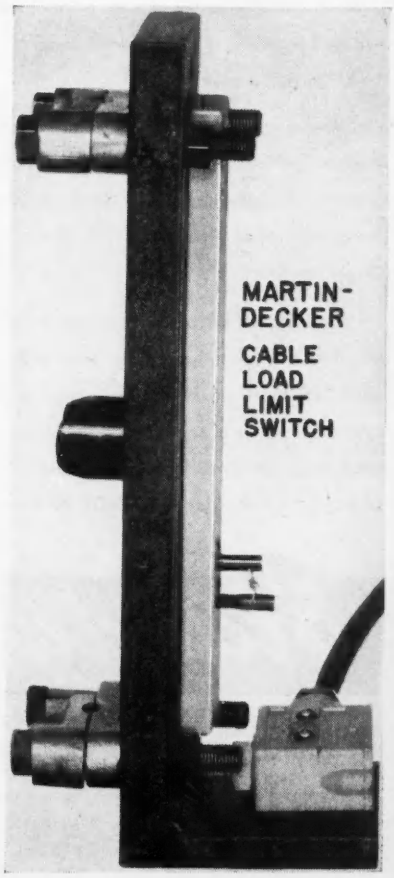
For additional information, write Oil Base, Inc., 130 Oris Street, Compton, Calif., *referring to* WORLD OIL *item* 12.

13—Switch

This item supplements Martin-Decker Corporation data as shown on pages 3089-3128 of Composite Catalog, 17th Edition.

The Cable Load Limit Switch, an instrument for operating an electric switch when the cable tension reaches a predetermined value, may be applied to any wire cable from ¼ to ¾-inch in diameter without cutting or removing the cable.

An alloy steel heat-treated rectangular beam is clamped on the cable, and an offset is placed in the cable which deflects the beam so that the loading will operate the switch. In order to set the switch at any predetermined load, an adjusting screw is provided. An auxiliary stud is provided for sealing the switch when used as a limiting device.



The load setting can be any value from 500 to 25,000 pounds single-line pull, which can be set either at the factory or by the purchaser.

For additional information, write Martin-Decker Corporation, 3431 Cherry Avenue, Long Beach 7, Calif., *referring to* WORLD OIL *item* 13.

Wilfel OILFIELD-EQUIPMENT

Made in Germany

Wuelfel Te 5/64 r Model
for 11,000 lbs. Polish Rod Load

60 More than

Years experience in Mechanical Engineering

20 and more than

Years experience in the design and manufacture of Oilfield-Equipment gained in all oilfields of the world are embodied in our high quality products:

PUMPING UNITS · CENTRAL POWERS · SINGLE OR DOUBLE DRUM WINCHES · TELESCOPING MASTS · ROTARY POWER TRANSMISSIONS · CANTILEVER DRILLING MASTS WITH WUELFEL GEAR TYPE DRAW WORKS ·

Please write for bulletin EW 4487

EISENWERK WUELFEL · HANNOVER-WUELFEL · GERMANY

NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

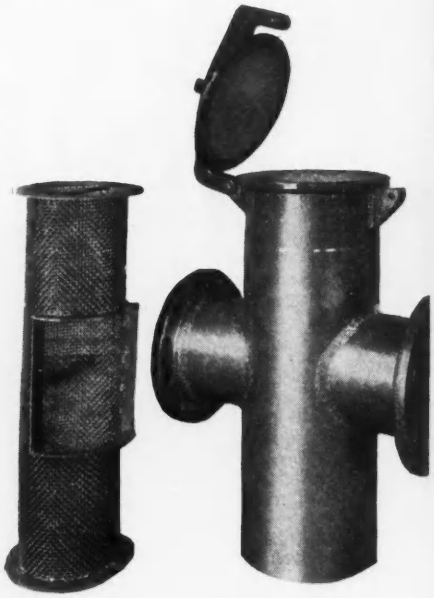
14—Suction Strainer

This item supplements S & R Tool and Supply Company data as shown on pages 4639-4376 of Composite Catalog, 17th Edition.

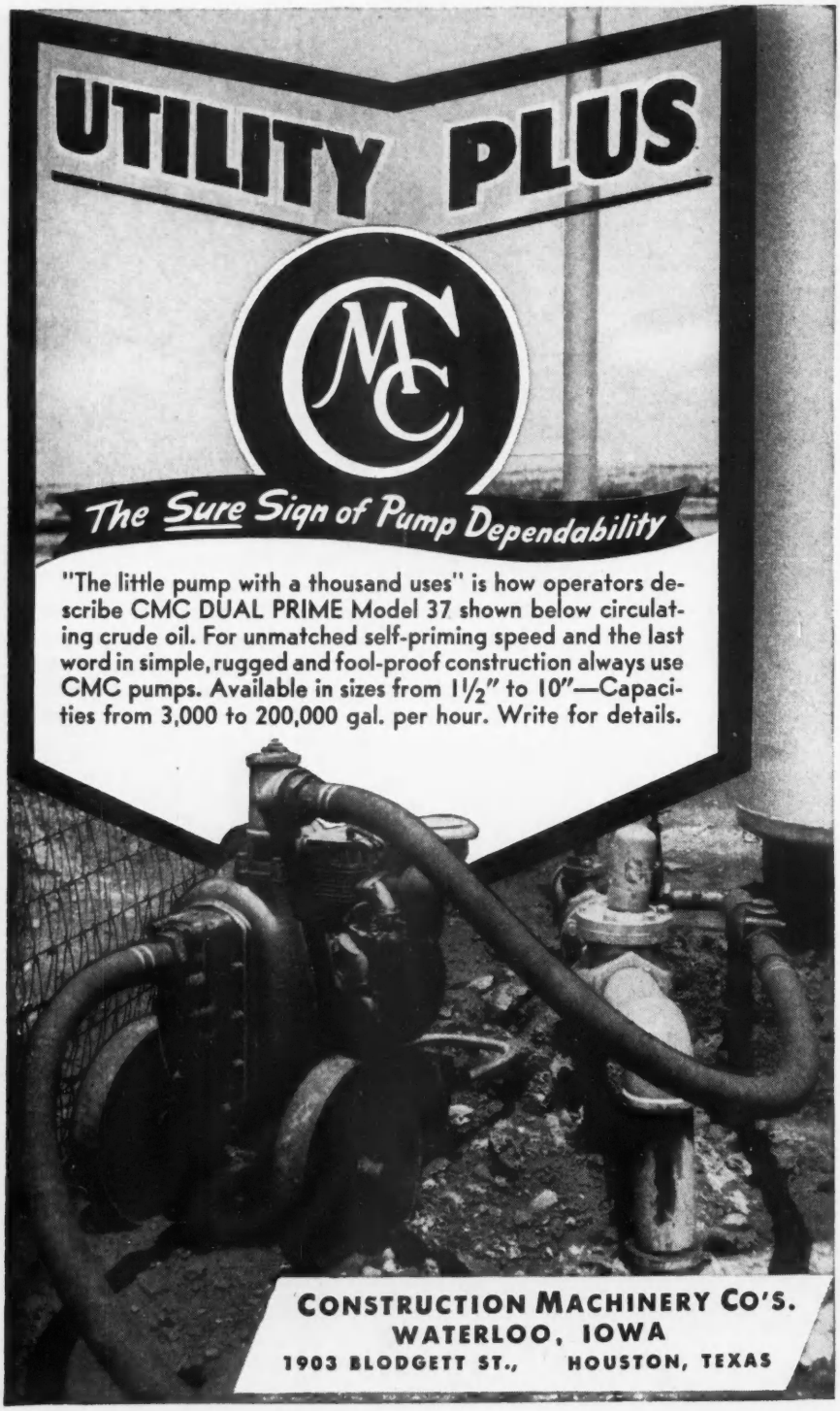
A new pump suction strainer consists of a steel barrel 13⅜ inches outside diameter, 36 inches long, with inlet and outlet of proportionate size. A flanged rim is provided at the top of the barrel, fitted with an O-ring, the only packing in the assembly.

The straining unit held within the barrel by a steel plate cap, is fabricated of heavy woven steel cloth, fitted with a solid steel bottom, a flanged top with a lifting bar, and a close fitting rigidly framed opening at the suction side. Slotted keyways provided within the barrel hold the strainer in position.

A heavy T-handle screw attaches the steel cap plate on the barrel to a cast steel yoke. This yoke is attached to ears on the barrel by steel pins which are slipped through mating holes in both pieces. Pins are provided with cotter keys to prevent vibrating out of place. To effect a pressure tight seal with the strainer in place, the T-handle screw is tightened by hand.

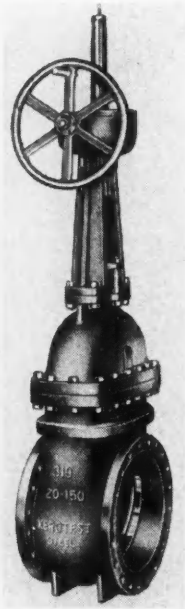


For additional information, write S & R Tool and Supply Company, Beaumont Highway, Houston, Texas, *referring to* WORLD OIL *item* 14.


UTILITY PLUS
CMC
The Sure Sign of Pump Dependability
"The little pump with a thousand uses" is how operators describe CMC DUAL PRIME Model 37 shown below circulating crude oil. For unmatched self-priming speed and the last word in simple, rugged and fool-proof construction always use CMC pumps. Available in sizes from 1½" to 10"—Capacities from 3,000 to 200,000 gal. per hour. Write for details.
CONSTRUCTION MACHINERY CO'S.
WATERLOO, IOWA
1903 BLODGETT ST., HOUSTON, TEXAS

15—Tank Valve

This item supplements Kerotest Manufacturing Company data as shown on pages 2613-2632 of Composite Catalog, 17th Edition.



A special tank valve for oil storage vessels is built for 230 pounds cold working pressure. The split wedge gate valve has added wall thickness and reinforcing to resist tension and torsional stresses set up by the tank connecting line.

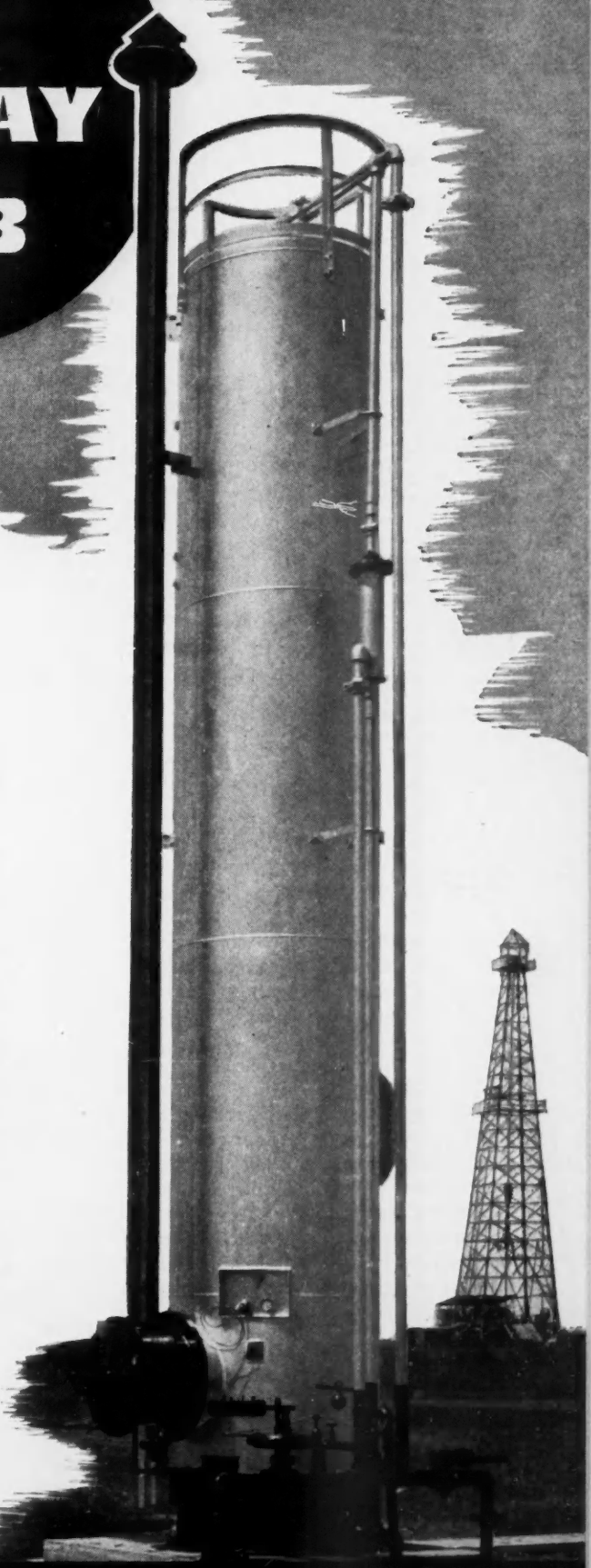
The valve is supplied in sizes ranging from 6 to 24 inches with any desired trim.

For additional information write Kerotest Manufacturing Company, 2525 Liberty Avenue, Pittsburgh 22, Penn., *referring to* WORLD OIL *item* 15.

PARKERSBURG EMULSION TREATERS

DO A 4 WAY JOB

1. THEY SEPARATE
2. THEY ACT AS A SETTLING TANK
3... THEY HEAT
4... THEY TREAT



. . . and they do those jobs *better* because of:

A double jacketed, BUILT-IN HEAT EXCHANGER. Regardless of liquid level in the treater or in the oil discharge line, the heat exchanger is always full of warm fluid and insulated from cold winter winds by a jacket of liquid on its way to the treating compartment. The result of this . . . plus more square feet of basic heat exchange area . . . is simply that the treated oil is cooler as it leaves for the tank. And, when fuel supply is critical, it's nice to know that all of the heat is being used to best advantage.

Parkersburg's exclusive design of a series of treaters equipped with completely INTERNAL PIPING. In addition to the large initial saving made possible by ease of erection, savings continue as unexposed piping reduces radiation loss. It looks better too. And to positively eliminate internal piping failure, the pipe is made specially heavy—in fact, heavier than any other portion of the vessel.

A section for FREE WATER KNOCK OUT minimizes the amount of fluid to heat and makes consistently uniform distribution of heat in the treating compartment more readily possible.

UNIFORM HEAT from a heating tube assembly which keeps itself free of soot and operates without developing hot spots which otherwise make long life impossible.

Ask your Parkersburg representative for details of these and other features and have him tell you of specific instances where Parkersburg Treaters are today solving problems exactly like yours.

THE PARKERSBURG RIG AND REEL CO.

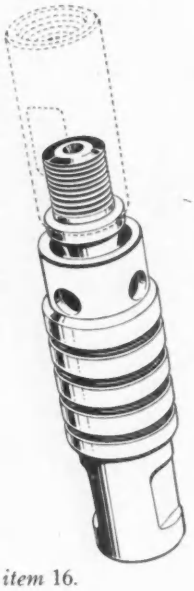
PARKERSBURG, WEST VA.

P A R K E R S B U R G

OTHER NEW AND IMPROVED EQUIPMENT

16—Stager

A new plunger-type fluid lift assister, the Hilton stager, connects directly into the sucker rod string at the coupling point, by means of standard rod connections. It thus operates as a piston with the tubing as its cylinder.



On upstroke of rods, the stager gives fluid lift assistance along the column being raised. On down stroke it provides controlled rod buoyancy that effects a balance between polished rod stroke and plunger travel. The number of stagers used is determined by the length of the fluid column being lifted.

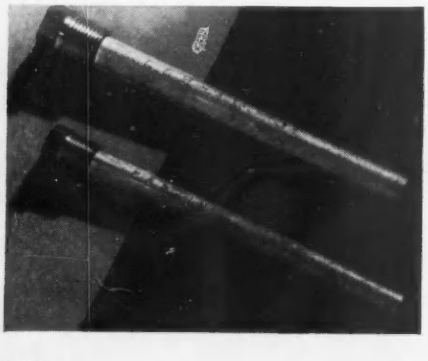
For additional information, write The L. D. Hilton Company, 508 Niels Esperson Building, Houston 2, Texas, *referring to* WORLD OIL *item* 16.

17—Zinc Plugs

Corrosion inhibitor zinc rods are fitted with standard pipe-plug ends, which screw into heat exchangers, piping and other hydraulic equipment to protect against corrosion.

The zinc rod has higher electro-chemical potential than the metals to be protected. Oxygen or other corrosives consume the zinc in preference to the electro-chemically less active metals of which pipes, tanks, and other hydraulic equipment are made.

The rod is tested for its reactivity ratio in water to insure that it will become more active when corrosive influences are severe while remaining more passive when corrosive conditions are mild. The zinc is activated by corrosive conditions in the water rather than by the water itself.



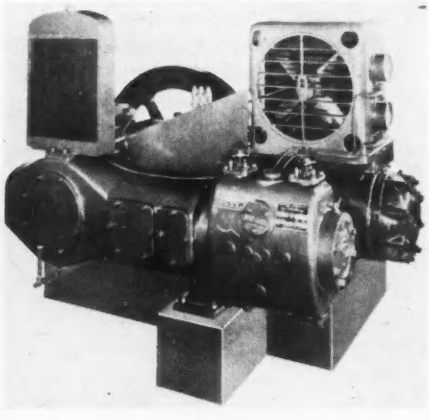
Renewal of the rods is accomplished by unscrewing the used-up zinc and screwing in a new one. The replaceable zincs can thus protect equipment for years after galvanizing has been eaten away. The rods come in ⅜, ½, ⅝, ¾ and one inch diameters, with lengths up to 12 inches.

Recommended to extend the corrosion-resistant life of water lines, tanks, heat exchangers and hydraulic equipment, the rods are used where corrosion may be aggravated by hot or salt water or other corrosive agents and catalysts or by the electrolytic action of dissimilar metals or stray currents.

For additional information, write Rotometals, Inc., 980 Harrison Street, San Francisco 7, *referring to* WORLD OIL *item* 17.

18—Gas Compressor

Two new units for compressing natural gas, or for use in the liquefied petroleum gas industry, are adaptable for industrial uses requiring gas at higher pressures. The Lorain Models L-7-S and O-7-S compressors are powered by



Lorain Model L and Model O multi-fuel engines, respectively.

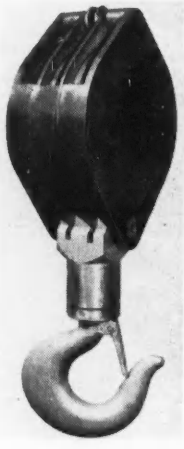
The single stage compressor is driven through a double-throw crank that reduces the ten-inch engine stroke to a seven-inch compressor stroke for high pressure work and to match compressor range to engine horsepower output.

Compressor cylinder has full force-feed lubrication including lubrication of metallic rod packings. Two independent cooling systems permit the compressor cylinder to be operated at a lower temperature than the engine. The compressor cylinder is designed with bottom discharge to prevent accumulation of gas condensates.

For additional information, write White-Roth Machine Corporation, Loraine, Ohio, *referring to* WORLD OIL *item* 18.

19—Swivel

Twisting and kinking of the wire lines in strung hoisting blocks is prevented through use of Miller angular thrust ball bearing swivels. Combined with the hook the swivels make it possible to turn loads independently of the block. They make placement of the load simpler, giving the hoist operator greater control and insuring greater safety. The freely turning, angular thrust swivels are also used on the dead end of strung blocks. When used in this manner, they make stringing or re-stringing much easier by automatically taking all the kink and twist out of the line. This corrects the usual tendency of the line to crawl over and the line follows the lead on the drum.



Complete assemblies are available combining the swivel with various sizes of blocks and hooks, or the swivels can be inserted in blocks now in use. They can be obtained in a wide range of capacities, handling up to 23 ton working loads with a safety factor of more than 5 to 1.

For additional information, write General Machine & Welding Works, 1100 East Second Street, Pomona, Calif., *referring to* WORLD OIL *item* 19.

20—Trencher

Eight forward speeds and two wheel speeds provide 16 forward digging combinations with the Profit trencher. Mounted on a Case tractor, the unit trenches to depths of more than 48 inches, and from 12 to 18 inches wide.

The trencher works within 30 inches of curbs and other obstacles.

For additional information, write Construction Products Corporation, 410 San Fernando Road, Los Angeles 31, *referring to* WORLD OIL *item* 20.

NI-RESIST...
AN ECONOMICAL METAL

for resisting Corrosion, Erosion and Metal-to-Metal Wear

NI-RESIST* is the trade name of a high nickel cast iron – one of the most economical corrosion-resistant engineering materials ever developed.

NI-RESIST, mechanically similar to gray iron, and resembling austenitic stainless steel in many characteristics, provides a unique combination of properties at moderate cost . . .

RESISTS CORROSION

NI-RESIST resists corrosive attacks of *acids*, *alkalies* and *salts* to a degree unmatched by any other product of the cast iron industry. In strong corrosives it has 20 to 200 times the resistance of plain iron, and 5 to 50 times the resistance in mild environments.

CURBS WEAR

NI-RESIST reduces wear and galling, because graphite particles are distributed throughout its structure, as in gray iron. From this, and its work-hardening characteristics, come the superiority of NI-RESIST castings for components in metal-to-metal wear service.

CHECKS EROSION

This superior wear-resistance . . . together with inherent resistance to corrosion . . . makes NI-RESIST an outstanding material for curbing erosion by liquids and slurries. By long, trouble-free control of erosion, NI-RESIST castings reduce maintenance costs, production tie-ups and the expense of replacements.

WITHSTANDS HEAT

Although primarily used to resist corrosion, erosion and metal-to-metal wear . . . NI-RESIST is also specified for resistance to elevated temperature effects. Castings of NI-RESIST show up to 10 times better scaling resistance, and up to 12 times better growth resistance than those of plain iron at 1300 to 1500°F.

MACHINABILITY and OTHER PROPERTIES

NI-RESIST of normal hardness can be machined as readily as gray iron of about 200 BHN.

NI-RESIST has high specific electrical resistance. Thermal expansion can be controlled, from 60 per cent higher than that of plain iron to a low approximating that of Invar.

NI-RESIST is usually lower in cost than most other corrosion-resistant alloys. It is produced by authorized foundries only, in all industrial centers of the country. NI-RESIST castings have no more limitations in size and complexity than those of any gray iron.

APPLICATIONS

Several types of NI-RESIST *are available. All provide the fundamental properties described above, and differ only in certain special characteristics to meet a variety of industrial demands.*

Applications include: Salt filter drums, oil refinery tube supports and headers, turbine nozzle rings, cylinder liners, valves and fittings, furnace rollers, textile rolls, comminuter parts, blow pit pipes, precision machine tool spindle heads, bridge, and work supports, magnet housings, sugar retorts, etc.

FULL INFORMATION

May we send you two booklets? One, entitled, "Engineering Properties and Applications of NI-RESIST," includes corrosion data on NI-RESIST and cast iron under 400 different corrosive conditions. The other, entitled, "Buyers' Guide for NI-RESIST Castings," lists producers of NI-RESIST castings. Both are yours for the asking. Write for them today.

*Reg. U. S. Pat. Off.

EMBLEM OF INCO SERVICE TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

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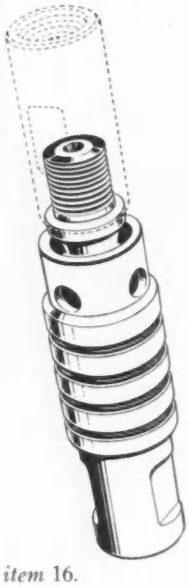

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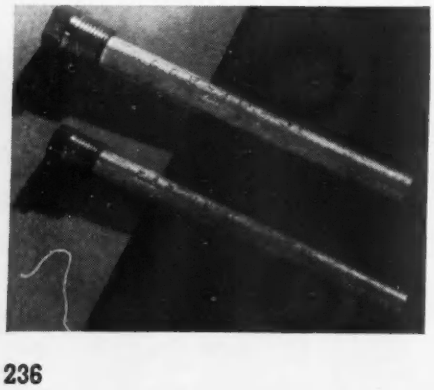

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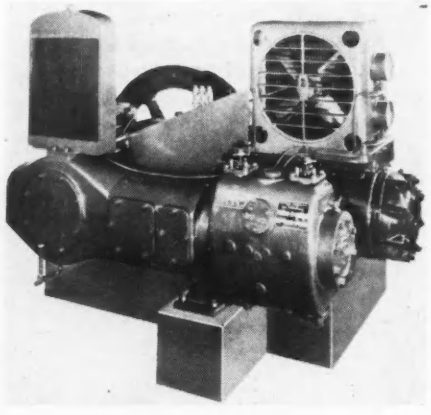

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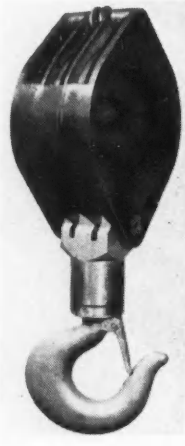

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This superior wear-resistance . . . together with inherent resistance to corrosion . . . makes NI-RESIST an outstanding material for curbing erosion by liquids and slurries. By long, trouble-free control of erosion, NI-RESIST castings reduce maintenance costs, production tie-ups and the expense of replacements.

WITHSTANDS HEAT

Although primarily used to resist corrosion, erosion and metal-to-metal wear . . . NI-RESIST is also specified for resistance to elevated temperature effects. Castings of NI-RESIST show up to 10 times better scaling resistance, and up to 12 times better growth resistance than those of plain iron at 1300 to 1500° F.

MACHINABILITY and OTHER PROPERTIES

NI-RESIST of normal hardness can be machined as readily as gray iron of about 200 BHN.

NI-RESIST has high specific electrical resistance. Thermal expansion can be controlled, from 60 per cent higher than that of plain iron to a low approximating that of Invar.

NI-RESIST is usually lower in cost than most other corrosion-resistant alloys. It is produced by authorized foundries only, in all industrial centers of the country. NI-RESIST castings have no more limitations in size and complexity than those of any gray iron.

APPLICATIONS

Several types of NI-RESIST *are available. All provide the fundamental properties described above, and differ only in certain special characteristics to meet a variety of industrial demands.*

Applications include: Salt filter drums, oil refinery tube supports and headers, turbine nozzle rings, cylinder liners, valves and fittings, furnace rollers, textile rolls, comminuter parts, blow pit pipes, precision machine tool spindle heads, bridge, and work supports, magnet housings, sugar retorts, etc.

FULL INFORMATION

May we send you two booklets? One, entitled, "Engineering Properties and Applications of NI-RESIST," includes corrosion data on NI-RESIST and cast iron under 400 different corrosive conditions. The other, entitled, "Buyers' Guide for NI-RESIST Castings," lists producers of NI-RESIST castings. Both are yours for the asking. Write for them today.

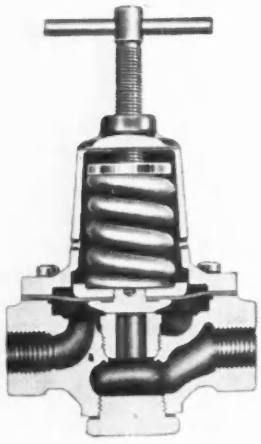
*Reg. U. S. Pat. Off.

EMBLEM OF INCO SERVICE TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

21—Relief Valve

When pressure exceeds the relief setting, diaphragm and valve seat of the "Series 62-A" diaphragm relief valve are



raised, opening the valve and releasing air or liquid through the outlet port. Surplus liquids can be discharged to supply tank by piping the outlet port.

All parts in contact with the air or fluid handled are brass. Synthetic rubber diaphragm, reinforced with nylon cloth, extends to the extreme outer edges of body and bonnet.

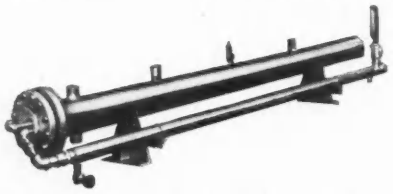
For additional information, write C. A. Norgren Company, 222 Santa Fe Drive, Denver 9, *referring to* WORLD OIL *item* 21.

22—Blowdown

Designed for small plants of less than 500 boiler horsepower, a new packet-type continuous blowdown automatically and continuously removes impurities from the boiler.

An automatic control is set to establish the amount of continuous blowdown in proportion to the quantity of makeup water and its impurities. This control then regulates the amount of blowdown for variations in the amount of makeup water added to the boiler system. Heat from the blowdown water is returned to the boiler by means of a Henszey heat exchanger.

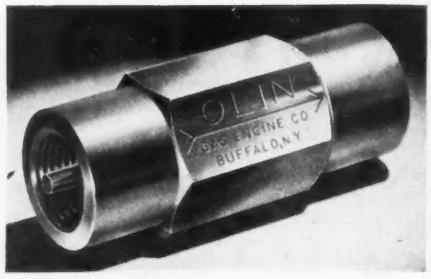
For additional information, write



Henszey Company, Water Street, Watertown, Wis., *referring to* WORLD OIL *item* 22.

23—Safety Valve

An automatic safety shutoff valve for use on compressed air lines is made to fit standard connections. It is inserted



at the intake end of the air hose, and when a break occurs in the hose the valve closes instantly and shuts off the pressure, permitting only a light stream of air to escape through a bypass. When the hose is repaired the pressure equalizes on both sides of the valve and a spring opens it automatically.

The valve is made of brass and has only one moving part.

For additional information, write Olin Gas Engine Company, 9 Lafayette Avenue, Buffalo, N. Y. *referring to* WORLD OIL *item* 23.

24—Horizontal Turbine

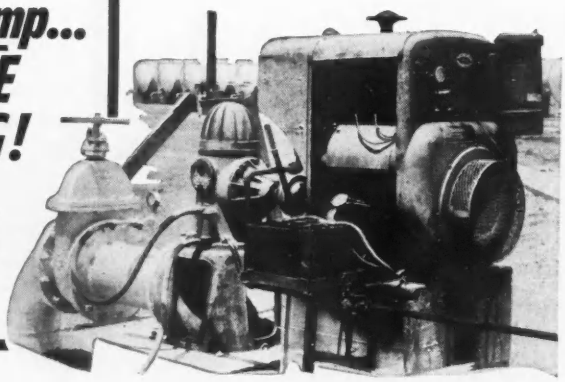
A new horizontal turbine develops 500 brake horsepower at 1750 revolutions per minute, with 850 to 900 pounds initial pressure, 850° F.

Casing is supported near the centerline of the turbine on pedestals. The turbine rotor is a solid one-piece wheel 48 inches in diameter, the blades being milled around the periphery of a solid

steel forging. The turbine is equipped with an oil relay actuated constant speed governor, separate emergency governor of the poppet type, gear driven oil pump, external oil cooler, and automatic back pressure trip.

For additional information, write Whiton Machine Company, New London, Conn., *referring to* WORLD OIL *item* 24.

Water to Pump... but NONE for COOLING! it's a WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINE



This 4-cylinder, V-type Wisconsin Engine handles the job of driving water pumps in a natural gas plant near Tye, Texas, operating in the open, exposed to fair weather and foul . . . with nary a cooling problem to worry about!

Here is AIR-COOLING at its best . . . efficient at temperatures from sub-zero to 140° F. . . . a feature of *all* Wisconsin Engines. But over and above air-cooling, the important thing about Wisconsin Engines is their ability to *stand the gaff*, thanks to heavy-duty design and construction. For example, All Wisconsin Engines run on file-hard, self-cleaning Timken tapered roller bearings at BOTH ends of the crankshaft . . . designed to take up end thrusts as well as radial loads. Incidentally, these bearings permit flexing of the shaft to a much greater degree than plain bearings . . . *and we have yet to hear of a case of roller bearing failure on Wisconsin Engines!*

Specify Wisconsin Heavy-Duty Air-Cooled Engines for power jobs from 3 to 30 hp. Supplied in single cylinder, 2 cylinder and V-type 4-cylinder models.

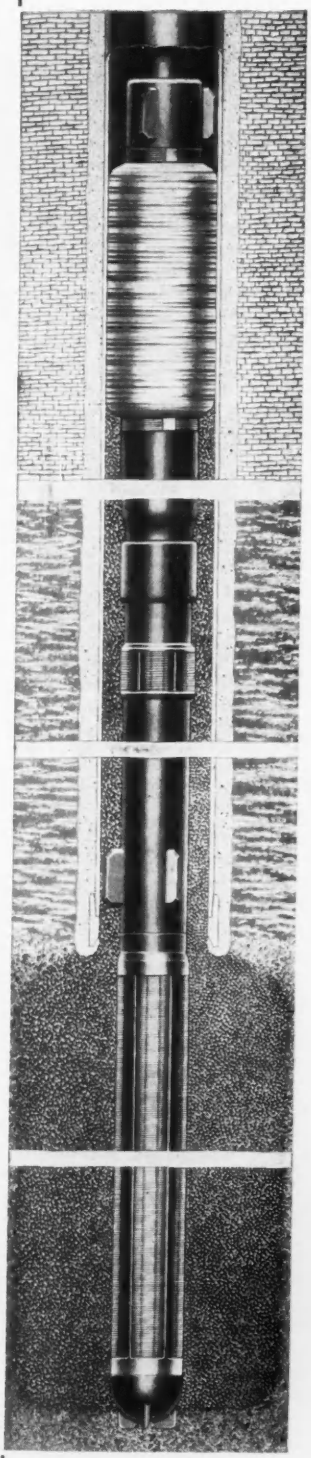
WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

"GRAVEL PACKING"

YOUR WELLS

PAYS DIVIDENDS



Gravel Pack
Open Hole Type Setting

Gravel is nature's greatest filter . . . it does not deteriorate . . . its length of life is unknown. When placed down in a well it supports the formation, protects the screen, and at the same time allows rapid and free separation of the oil from the sand. With the gravel controlling the sand, it assures a longer, more constant flow of clean oil, doing away with costly shut-downs.

☆

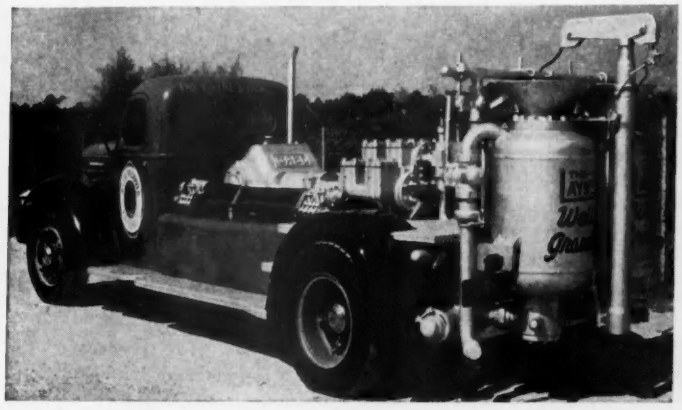
ELIMINATES EXPENSIVE REWORKING

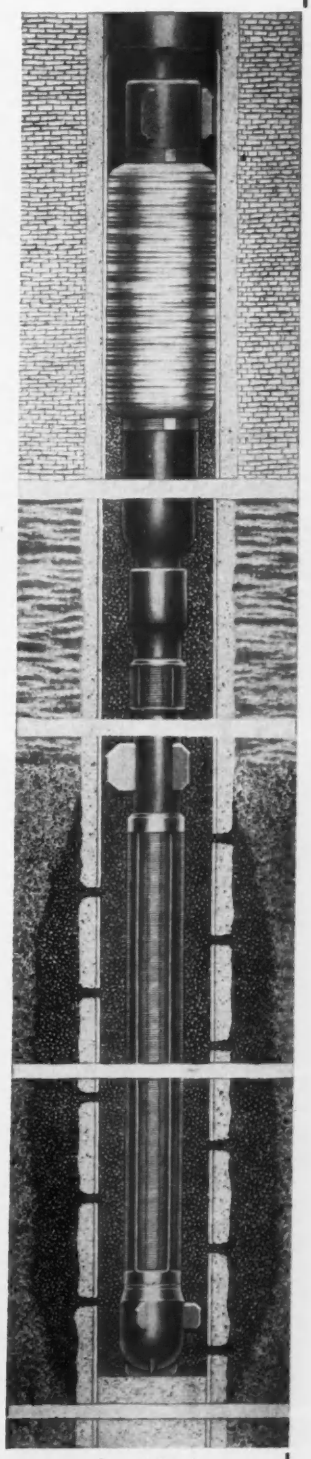
Because the Gravel Pack can neither deteriorate nor enter the screen and because it permanently supports the formation and filters the flow, you are not confronted with the frequent expense of pulling tubing to replace sanded up screen and sand cut parts and other expenses involved in reworking wells.

☆

LENGTHENS LIFE OF THE WELL

Gravel Packing controls the productive sands. It surrounds the strainer with a natural filter, coarse enough for the oil to flow through, yet fine enough to retain the oil sand in its natural state of formation. Acting as a baffle, the gravel distributes the flow through the countless channels, lowering the velocity and preventing disruption of the fine grains of sand resulting in longer life for the well and equipment.





Gravel Pack
Thru Perforated Casing

THE LAYNE & BOWLER COMPANY

General Office & Factory

8000 MARKET STREET **HOUSTON, TEXAS**

25—Machinery

Information on thousands of individual oil field equipment items made by the leading manufacturers represented by The Continental Supply Company is contained in the company's 1949 Machinery Catalog. It is the company's third catalog, and the first postwar edition.

Divided into three sections covering all types of equipment in the drilling, producing and pipe line fields, the catalog has 729 pages. Included also are engineering data such as power curves, dimensional drawings, tables, etc.

For a copy of this catalog, write The Continental Supply Company, Continental Building, Dallas, Texas, *referring to* World Oil *item* 25.

26—Geophysics

Factors comprising seismic surveys and biographical sketches of key company staff members are presented in a new 16-page brochure. Field operations and technical and automotive equipment are illustrated.

For a copy of this brochure, write Southern Geophysical Company, Sinclair Building, Fort Worth, Texas, *referring to* World Oil *item* 26.

27—Gas Scrubbers

Presenting detailed engineering data, cross-sectional illustrations of operational features and high and low pressure charts for use in selection of the proper size of scrubber, the Aerotec Corporation has issued a bulletin entitled "Gas Scrubbers" that is available on request.

For a copy of the bulletin write to The Aerotec Corporation, First National Bank Building, Greenwich, Conn., *referring to* World Oil *item* 27.

28—Aerial Mapping

Basic principles of techniques employed in producing aerial topographic maps are explained in a new brochure, "Wings for the Transit." The publication exhibits samps of aerial photographs, stereoscopic pairs, mosaics, and photogrammetric maps.

For a copy of this brochure, write Lockwood, Kessler & Bartlett, Inc., 32 Court Street, Brooklyn 2, N. Y., *referring to* World Oil *item* 28.

29—Fire Extinguisher

Two models of dry chemical fire extinguishers are described in a new two-color folder. The folder details 12 design features of the extinguishers, which are adapted to fight flammable liquid, gas and electrical fires.

For a copy of this folder, write Ansul Chemical Company, Fire Extinguisher division, Marinette, Wis., *referring to* World Oil *item* 29.

30—Oil Hose

Oil hose for cargo handling, and gasoline and fuel oil hose for curb pump, tank truck and tank service, are described in new catalog sections. Recommended uses, detailed specifications, pictures and descriptions of the hose, fittings and couplings are included.

For a copy of these catalog sections, write The B. F. Goodrich Company, Akron, Ohio, *referring to* World Oil *item* 30.

31—Cable Vulcanizers

Electric cable vulcanizers are described and suggestions for use are given in a new 16-page, two-color bulletin. Models and molds for popular cord and cable diameters are listed.

For a copy of this bulletin, write Mines Equipment Company, Clayton and Thomas Avenues, St. Louis, Mo., *referring to* World Oil *item* 31.

Bottom Water is a drain on profits

Eagle Lead Wool

shuts out Bottom Water!

To insure an uninterrupted flow of oil from your wells, banish bottom water with economical Eagle Lead Wool. This finely stranded metallic wool, tamped around the hole, effectively seals every crack, becomes a permanent, non-corrosive plug. Packed in convenient 50-pound sacks—easy to place in special cartridge-shaped Eagle Wire Containers sized to fit all casings.

These 3 Eagle Bearing Metals meet most requirements

Eagle Dreadnaught — for extreme speed and heavy-duty conditions.

Eagle Outlasta — for medium speed and average-load conditions.

Eagle Durable—for low speed and light-duty conditions.

EAGLE LEAD WOOL

Seals off Bottom Water— keeps 'em flowing!

THE EAGLE-PICHER COMPANY

EAGLE Since EP 1843 PICHER

Cincinnati . East St. Louis
Chicago . Dallas . Kansas City

MARSH GAUGES

Under the grind
of daily service
Marsh Gauges
stand out
as the kind that
maintain
their accuracy.

JUST OFF THE PRESS

New, fact-filled catalog covering Marsh instruments. Ask for your copy.

Marsh Instrument Co. Sales Affiliate of

JAS. P. MARSH CORP., DEPT. K, SKOKIE, ILL.

The Jas. P. Marsh line includes gauges especially designed for blenders, boilers, burners, capping, Christmas trees, columns, heaters, hydrogen units, instrument panels, pumps, Reid vapor bombs, scrubbers, separators, mud pumps, stills, towers, and other applications including oxygen and welding gauges.

AAODC Will Meet in Tulsa; Chapter Officers Are Chosen

Tulsa has been selected as host city for the Tenth Annual Meeting of the American Association of Oilwell Drilling Contractors, and the dates of October 9-10 have been set. Standing committees of the association will meet October 7-8.

H. W. Davidson, Davidson Drilling Company, Odessa, was elected chairman of the Permian Basin Chapter, succeeding M. M. Conn, Trinity Drilling Company. C. K. Lowe, W. H. Black Drilling Company, Midland, Texas, was elected vice chairman. Don Johnson, Carl B. King Drilling Company, Midland, was named secretary, and Gordon Oliver, University of Texas, was appointed assistant secretary.

The Shreveport Chapter has been reactivated and Charles W. Glasscock, Glasscock Drilling Company, has been elected chairman. Other officers elected include N. H. Wheless, Jr., Wheless Drilling Company, vice chairman; B. M. Nowery, Nowery Drilling Company, Inc., secretary; and W. A. Brown, Jr., J. I. Roberts Drilling Company, treasurer.

F. W. Brigance, vice president of Rowan Drilling Company, was elected chairman of the Dallas-Fort Worth Chapter AAODC. He succeeds Louis A. Beecherl, McDaniel & Beecherl Drilling Company, who is treasurer of the association. William L. McClusky, M. J. Delaney Company, was elected vice chairman and Kye Trout of the AAODC staff in Dallas, was appointed chapter secretary.

The Oklahoma City Chapter re-elected all officers for the coming year. They are Earl Flesher, Johnson-Flesher Drilling Company, president; Jack Abernathy, Big Chief Drilling Company, vice chairman; Brad Mills, Dallas, executive secretary; and W. R. Ewert, Kerr-McGee Oil Industries, Inc., secretary-treasurer.

B. E. Groenewold, Exploration Drilling Company, was elected chairman of the Tulsa Chapter, succeeding Frank Stickle, Stickle Drilling Company. Other officers include A. F. Keating, Keating Drilling Company, vice chairman, and Robert L. Parker, Parker Drilling Company, secretary.

W. R. Martin Is Honored By California Jaycee Group

W. R. (Frosty) Martin, pioneer contractor oil man, and founder of the Martin-Decker Company of Long Beach, Calif., was the honored guest at a dinner given by the Long Beach Junior Chamber of Commerce "on behalf of all those for whom he has done so much."

Since disposing of his interest in the Martin-Decker Company to his partner, Elmer Decker, several years ago, Frosty has devoted most of his time to civic affairs, notably the Harbor Commission of Long Beach. For the past ten years he has been president of the Board of Harbor Commissioners at Long Beach. At 77 years of age Frosty is still a youngster, full of pep and fun, tempered by a lifetime of interesting experiences.

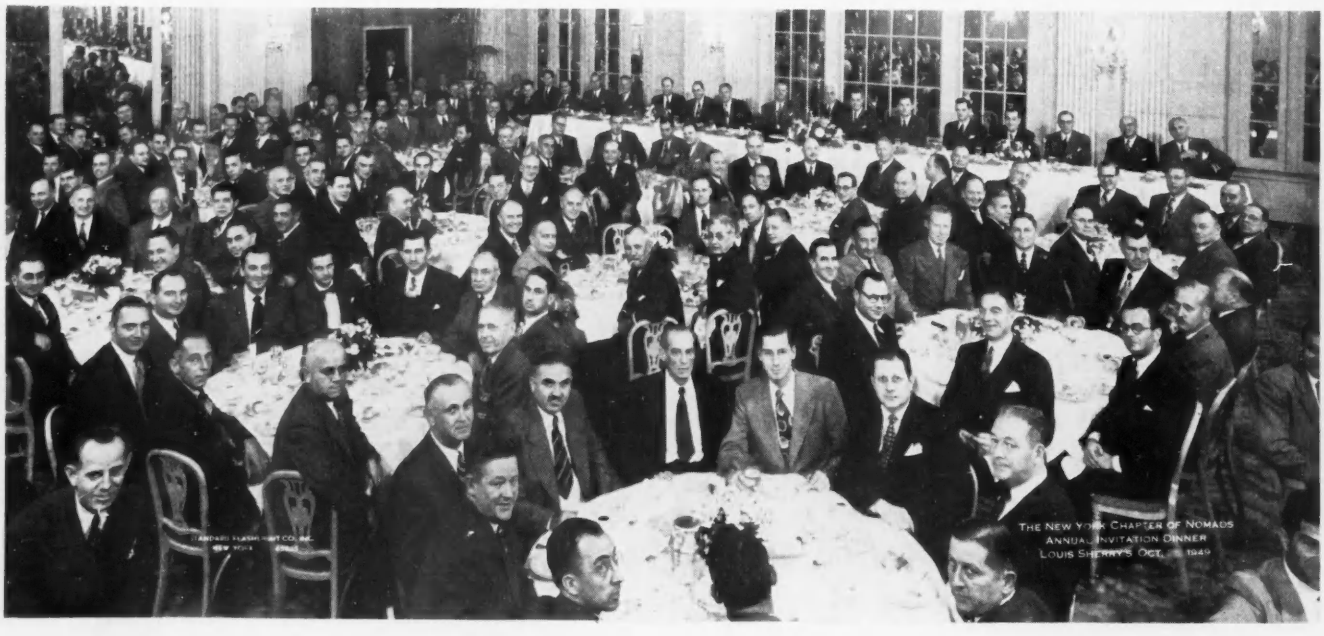
Mid-Continent Oil and Gas Leaders Returned to Office

Officers of the Mid-Continent Oil and Gas Association were re-elected at the annual meeting in Tulsa. They are F. M. Porter, Fain-Porter Drilling Co., Oklahoma City, president; J. L. Hamon, Cox & Hamon, Dallas, first vice president; William T. Payne, Big Chief Drilling Company, Oklahoma City, vice president for Oklahoma; H. E. Zoller, Derby Oil Company, Wichita, vice president for Kansas; R. B. Anderson, W. T. Waggoner Estate, Vernon, Texas, vice president for Texas; A. H. Weyland, Arkansas-Louisiana Gas Company, Shreveport, vice president for Louisiana; C. H. Murphy, C. H. Murphy Company, El Dorado, Ark., vice president for Arkansas; James P. Evans, Jr., independent, Jackson, Miss., vice president for Mississippi; James L. Duffy, J. L. Duffy Company, Grove Hill, Ala., vice president for Alabama; Clarel B. Mapes, Tulsa, secretary-treasurer.

Carper Is Chosen Chairman of New Mexico Oil and Gas Group

Emery Carper, Artesia, N. M., oil man, was elected president of the New Mexico Oil and Gas Association at the 21st annual meeting of the group at Albuquerque.

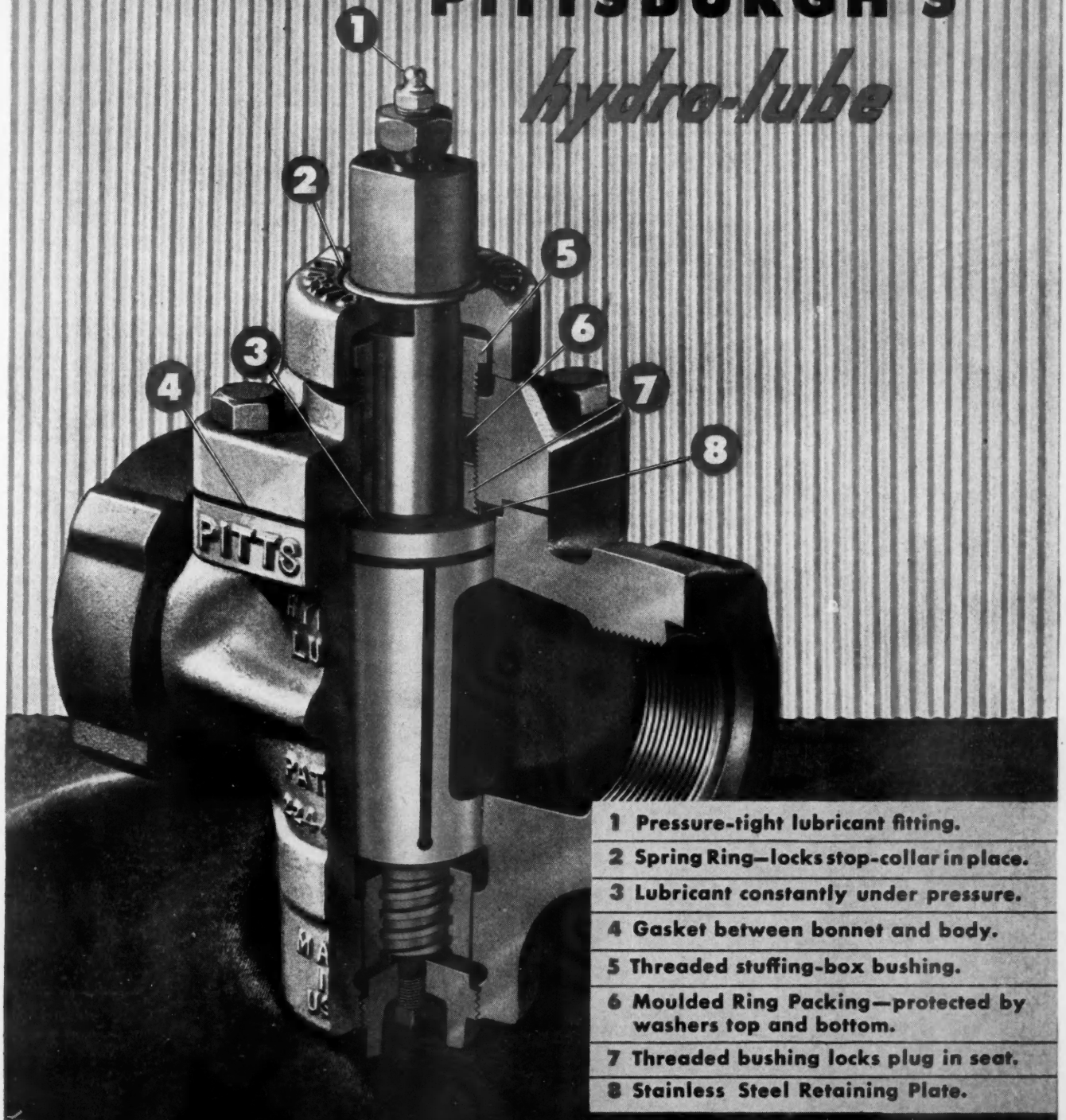
Other officers elected included Van S. Welch, vice president; John M. Kelly, treasurer; and Jack Danglade, Dan Bodie, Emmett White, Joe Lackey, Dudley Cornell, Jim Dunlavey, Ralph Hendrickson and Bill Macey to the executive committee.



NEW YORK NOMADS are pictured at their annual invitation dinner. Dr. Wilson Compton, president of Washington State University and a member of the U. S. delegation to the United Nations, was principal speaker.

Look at These NEW SAFETY FEATURES in

PITTSBURGH'S *hydro-lube*



1 Pressure-tight lubricant fitting.
2 Spring Ring—locks stop-collar in place.
3 Lubricant constantly under pressure.
4 Gasket between bonnet and body.
5 Threaded stuffing-box bushing.
6 Moulded Ring Packing—protected by washers top and bottom.
7 Threaded bushing locks plug in seat.
8 Stainless Steel Retaining Plate.

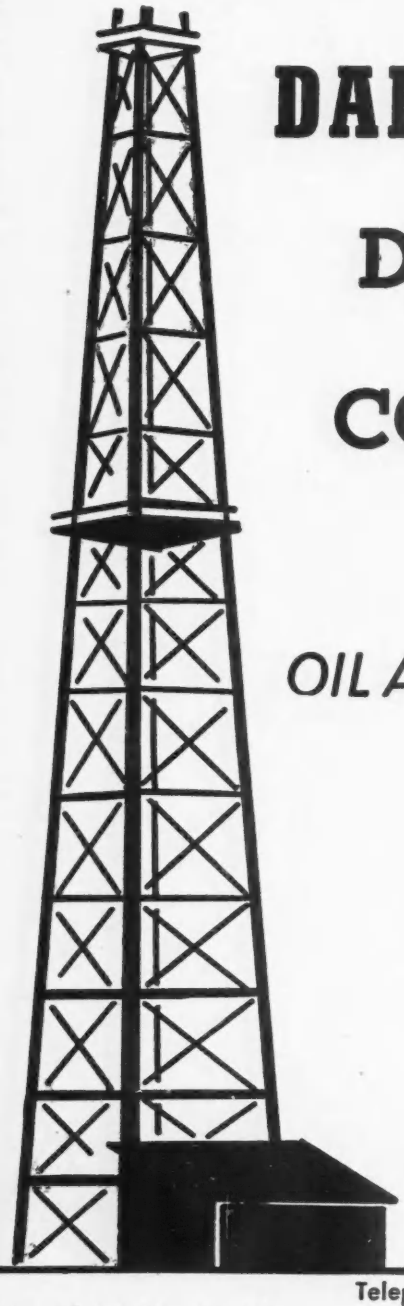
Write for full details today.

PV PITTSBURGH

SINCE 1902
PITTSBURGH VALVE & FITTINGS CORP.
BARBERTON, OHIO, U.S.A.

NEW OFFICERS of the Dallas Petroleum Engineers Club for 1950 are, left to right, Dr. H. B. Renfro, secretary-treasurer; A. E. Carraway, third vice president; G. R. Brainard, second vice president; Henry J. Gruy, president; Edward C. Cram, first vice president; and T. S. Bacon, retiring president.

DAN L. CLARK W. M. AVERILL RUPERT COX



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Pipe Line Contractors Meet In Houston; Elect Officers

Second annual convention of the Pipe Line Contractors Association of the Associated General Contractors of America was held in Houston December 14, with 175 representatives of the 32 active members and associate members present.

Ray L. Smith, president of Ray L. Smith & Son, Inc., El Dorado, Kansas, was elected president of the association. Other officers are, vice presidents, L. H. Favrot, president of Latex Construction Company, Houston, and E. G. Morrison, Morrison Construction Company, Austin; treasurer, N. A. Saigh, president of N. A. Saigh Company, San Antonio; and executive secretary, Richard A. Gump, Dallas.

Principal speaker at the convention was R. Elmo Thompson, vice president and director of the First National Bank and Trust Company, Tulsa.

W. F. Brown Elected Chairman Of Kansas Section AIME

W. F. Brown, Dowell Incorporated, Wichita, was elected chairman of the Kansas Section, AIME. Other officers are Fred Kluck, The Ohio Oil Company, Eureka, vice chairman Eastern Kansas; W. R. Warren, Stanolind Oil and Gas Company, vice chairman Western Kansas; P. T. Amstutz, Jr., Amstutz and Yates, Inc., vice chairman for Wichita; Louis Chombart, Schlumberger Oil Well Surveying Company, secretary-treasurer. Carl Temple, Sohio Petroleum Company, Independence; Herb Roberson, Dowell, Great Bend; and Lester Wilkinson, Sunflower Natural Gas Company, were named directors.

Roy J. Turner Heads IOCC

New chairman of the Interstate Oil Compact Commission is Governor Roy J. Turner of Oklahoma, who succeeds Governor Frank Carlson of Kansas. Vice chairmen are James McClure, Jr., of Jackson, Miss., and H. J. Wagner of Charleston, W. Va.

FIRST CHOICE
Thermoid
Powerflex Rotary Hose
Tube—Synthetic rubber . . . abrasion and oil resistant . . . free circulation and long life assured.
Reinforcement—Steel cables and pre-stretched fabric for the greatest strength and flexibility.
Cover—Special vulcanized compound resists aging and abrasion.
Couplings—Streamlined steel . . . full flow built-in and anchored securely for the life of the hose.
It will pay you to Specify Thermoid!
EVERY LENGTH PRE-TESTED TO 5000 PSI BEFORE SHIPMENT
Also
TRIOFLEX
Slim-Hole Rotary Hose
for Portable Rigs, Seismograph and Workover Service. Tested to 2000 psi before shipment.
SEE OUR CATALOG IN THE COMPOSITE CATALOG

Thermoid Quality Oil Field Products: Oil Country Flat Belting • Wire Line Turn Backs • No-Wip Line Savers • Stuffing Box Rings • All types of Hose • Molded Specialties • Powerflex Rotary Hose • Mud-Flo Slush Pump Hose • Flexible Discharge Units • Brake Blocks • F. H. P. and Multiple V-Belts.

Thermoid Company

Western Offices and Factory • Nephi, Utah, U.S.A.
Main Offices and Factory • Trenton, N. J., U. S. A.
Industrial Rubber Products • Friction Materials • Oil Field Products

BETHLEHEM "TORNADO" RIGS

give the driller centralized command with

W·A·B

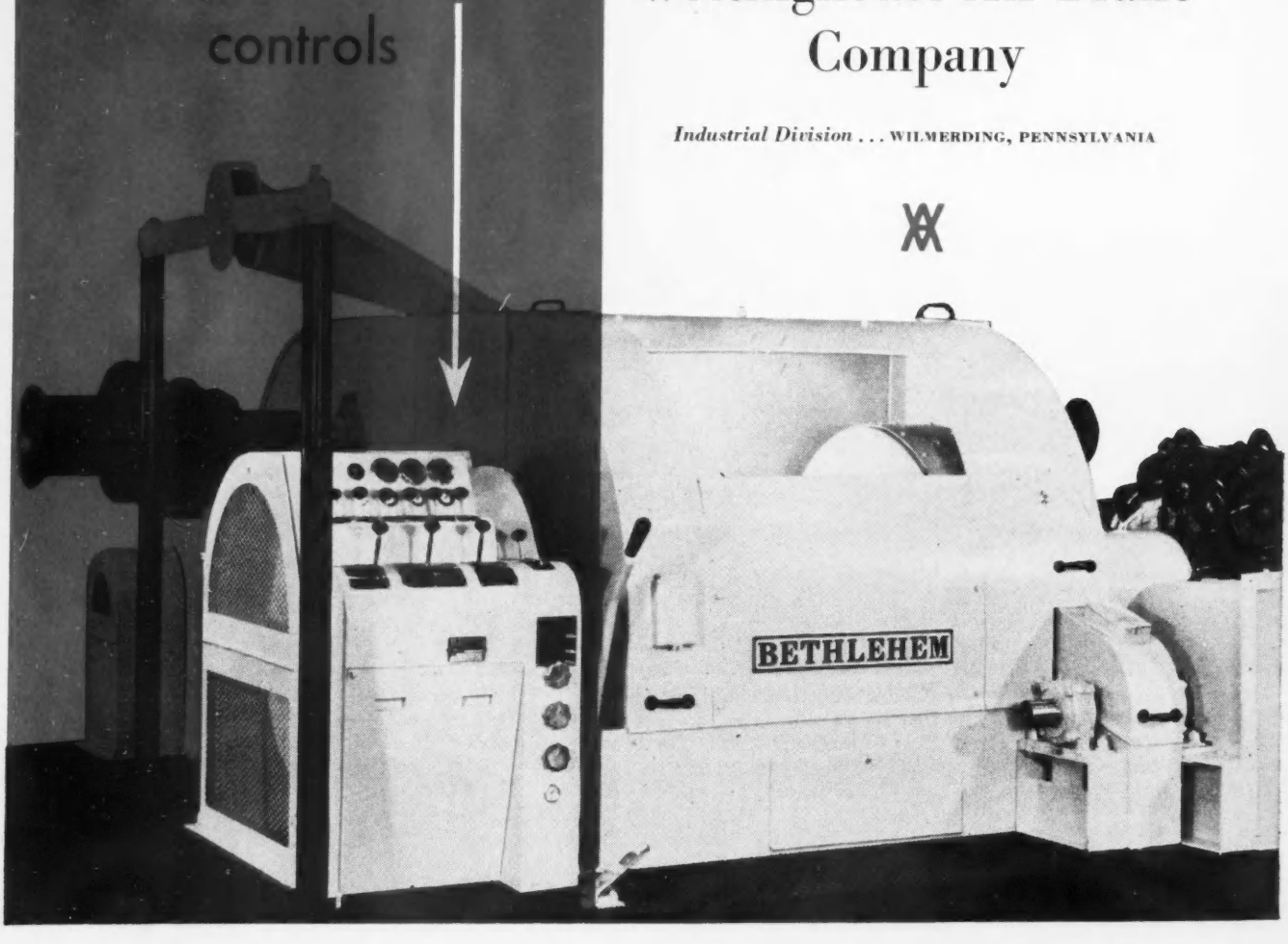
Enginaired controls

Today's bigger, more powerful rigs are too much for one driller to handle—unless he has the kind of help that W·A·B Engin*aired* controls can provide. With full air control of all drawworks operations, there is instant direct action on all speed changes, with no lost motion . . . and with everything under the direct command of the driller.

All major operations in the drawworks, compounding elements, pumps, auxiliary brake and utility unit are easily and quickly controlled at the driller's position by finger or foot-actuated feather-touch valves. Individual or multiple control of engines, is available, as desired. All controls are arranged so that the driller can readily manipulate them while facing the rotary table and floor operations.

Westinghouse Air Brake Company

Industrial Division . . . WILMERDING, PENNSYLVANIA



A MOMENT DURING THE KURTH DINNER is pictured as Governor Allan Shivers of Texas speaks. Left to right are Ernest L. Kurth, honor guest; A. E. Cudlipp, Lufkin Foundry & Machine Company, master of ceremonies; Governor Shivers; and Senator Tom Connally of Texas.

Tribute Paid E. L. Kurth, Lufkin Industrial Leader

On the keynote of paying tribute to a living example of what free enterprise can accomplish, hundreds of visitors, including high government officials and business leaders, gathered at Lufkin, Texas, on December 14 to honor Ernest Lynn Kurth.

An all-day program was climaxed by a dinner at which Kurth was presented two awards. One was a certificate from *Dixie Business Magazine* certifying that he was chosen "Man of the South for 1949." The other was a certificate from the Texas Manufacturers Association naming him "Industrialist of the Year."

Kurth's first business enterprise was in the lumber industry. Today he is a national figure in this business, but has expanded into many other fields. He is head of 16 firms, including an insurance agency, theater chains, and a paper mill. He is a director of many other firms, including Lufkin Foundry and Machine Company. Much of the credit for the manufacturing of newsprint paper from yellow pine must go to Kurth. Backing the idea when experienced paper manufacturers said it could not be done, he organized Southland Paper Mills. The company constructed a huge paper plant east of Lufkin which was the first, and remains the only, newsprint mill in the world manufacturing newsprint from southern pine.

Among those attending were U. S. Senators Tom Connally and Lyndon Johnson of Texas, Governor Allan Shivers of Texas, and former Texas Governor W. P. Hobby. A. E. Cudlipp, Sr., vice president of Lufkin Foundry and Machine Company, was master of ceremonies.

Freyermuth Elected Information Committee Chairman

George Freyermuth, manager of the Public Relations department of the Standard Oil Company (N. J.) New York, was elected 1950 Chairman of the Oil Industry Information Committee.

Freyermuth will succeed Conger Reynolds, manager of the Public Relations department, Standard Oil Company (Ind.).

Three vice chairmen also were elected. They are Phillip Humphrey, The Texas Company, New York; and Stanton Smith, of Smith Oil & Refining Company, Rockford, Ill., and William Gerwe, of Socony-Vacuum Oil Company, Inc., Chicago.

Tulsa Pipe Liners Choose Officers to Serve in 1950

The Pipe Liners Club of Tulsa has elected as president for the 1949-1950 term P. L. Reichard, assistant general superintendent, Gulf Refining Company, Pipe Line division, Tulsa.

J. D. Jones, master mechanic of Gulf Refining's Pipe Line division, is vice president. Other officers are, secretary, F. C. Whiteside, assistant chief engineer, Interstate Oil Pipe Line Company, Tulsa; and treasurer and assistant secretary, G. G. Billings, assistant area superintendent, Shell Pipe Line Corporation, Cushing, Okla.

Oil Scouts Will Meet

The 1950 national convention of the National Oil Scouts and Landmen's Association will be held at the Skirvin Tower Hotel in Oklahoma City on June 8, 9 and 10.

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Contracts accepted for domestic and foreign projects, using the most improved instrumental and interpretative technique.

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Longer Thread Life WITH Jimmie Gray COMPOUNDS

KANT-GALL TOOL JOINT COMPOUNDS

EXCLUSIVE 500-TON SPECIAL

LONG-LIFE DRILL COLLAR COMPOUND

You can always break the joint when you use Jimmie Gray Compounds! That's because each one is engineered to do certain specified jobs best! You can depend on their thread-protecting film to prevent galling and washouts, too. Satisfaction is assured thru the famous Jimmie Gray money-back guarantee!

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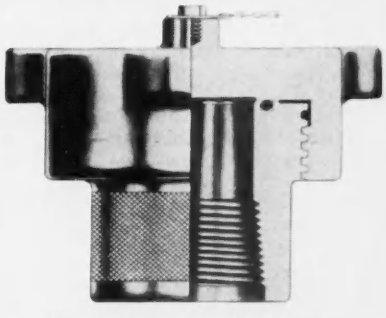

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Men in the Industry NEWS

A. E. Pecore has been named general superintendent of Humble Pipe Line Company, with headquarters at Houston. Eight other executives promoted by the company are **F. D. McMahon,** superintendent of the company's West Texas division with headquarters at Midland; **Jack Jones,** superintendent of field operations of the entire pipe line company; **H. M. Stevenson,** manager of planning and economics; **C. H. Lundt,** chief engineer; **P. D. Phillips,** assistant chief engineer; **C. C. Moore,** coordinator of personnel and policy; **L. E. Grissom,** secretary and superintendent of oil movements; and **E. L. Krueger,** assistant secretary and assistant treasurer.

A. E. Pecore

Pecore started with the company in 1919, and has been chief engineer since 1945. He recently completed the advanced management course at the Harvard Graduate School of Business.

McMahon, who has been with the company 30 years, has been assistant general superintendent (field operations) of Humble Pipe Line Company. Jones, who since 1941 has been assistant division superintendent at Midland, joined the company in 1928. Stevenson was formerly assistant general superintendent (Engineering and Development). Lundt has been with the company 26 years and was previously assistant chief engineer.

Phillips joined the company in 1934, and has been supervising mechanical engineer. Moore has been personnel coordinator and assistant secretary of the company, and will now devote full time to coordinating personnel and policy. Grissom, who has been with the company 30 years, has been board of directors member, secretary and assistant treasurer. Krueger has been assistant to the treasurer.

•

Dr. H. H. Kaveler, assistant to the vice president, Phillips Petroleum Company, Bartlesville, Okla., has been named chairman of the North Burbank Unit which has been organized to water-flood approximately 22,000 acres in the Burbank pool, Okla. **S. G. Sanderson,** Gulf Oil Corporation, and **Z. Z. Hunter,** Phillips, were chosen vice chairman and secretary, respectively.

•

R. E. Nelson, Jr., has been appointed general manager of crude oil supply and products pipe lines for Standard Oil Company (Indiana), with headquarters in Chicago.

For the past six months Nelson has been assistant to the president of Stanolind Pipe Line Company, Tulsa.

C. F. Firmin has been appointed assistant chief engineer of The Ohio Oil Company's Pipe Line department. Firmin joined the company at Findlay, O., in 1933, and was transferred in 1938 to the Refinery Engineering department at Robinson, Ill. He returned to Findlay in 1943 as an engineer in the Pipe Line department.

Clare McElhinny has been named assistant division superintendent of the Wyoming Pipe Line division. He has been superintendent of the Greybull, Wyo., district since June, 1945. McElhinny is succeeded by **E. E. Phillips,** formerly assistant superintendent of the Greybull district.

•

H. C. Petersen, superintendent of land and exploration for Freeport Sulphur Company for the past six years, has been named manager of the company's new Oil and Gas division.

Wayne Bowman, consulting petroleum geologist, will be in charge of the Houston office. A graduate of the University of Texas, Bowman has been with the oil industry since 1920. He has been engaged in private consulting geological work in Houston since 1937.

•

David L. Dooley, petroleum engineer, Stanolind Oil and Gas Company, Oklahoma City, has resigned to form the Dooley Engineering Company, handling reservoir and production engineering, valuation, drilling and production management, with offices in the Perrine Building, Oklahoma City.

INDIAN CHIEF is the new title of L. F. McCollum, president of Continental Oil Company, who has been made a chief of the Kiowa Indian tribe of Oklahoma. He was given the tribal title of Chief Yea-gau-aim-oie, which means "the great organizer."

A. L. Roberts has been appointed superintendent of the pipe line system, and **H. L. Stowers** has been named chief engineer for Texas Gas Transmission Corporation.

Roberts joined the Engineering and Construction division of the Empire Company at Bartlesville, Okla., in 1927. He became district pipe line superintendent in 1930 for Kentucky Natural Gas Corporation, a predecessor company of Texas Gas.

A. L. Roberts

H. L. Stowers

Stowers was employed by Memphis Natural Gas Company, also a Texas Gas predecessor, in 1937 as assistant chief engineer. He was made chief engineer of the Memphis company in 1944.

Duncan K. Foulds and **Monty G. Martin** have been named to staff the Shreveport office of Texas Gas Transmission Corporation.

•

Harold Decker of Houston was made a director of each company and was elected president of Houston Oil Company of Texas and also president of Houston Pipe Line Company, succeeding the late George A. Hill, Jr.

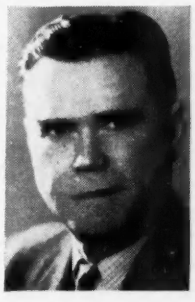
He assumes his new duties January 1.

Harold Decker

Decker was formerly with The Seaboard Oil Company of Delaware as district superintendent for the Coastal and Southwest Texas area, with headquarters in Corpus Christi. In February, 1945, he left Seaboard to become assistant manager of Pan American Production Company, Pan American Pipe Line Company and Pan American Gas Company. In August, 1947, he was elected vice president, general manager and director of Pan American Production Company and Pan American Gas Company, remaining with them until he accepted his present positions with the Houston Oil Company and Houston Pipe Line Company. Decker attended Kenyon College at Gambier, O., and the University of Oklahoma, majoring in petroleum engineering.

MEN IN THE INDUSTRY NEWS

Morgan Walker has been appointed consultant to Iraq Petroleum Company, Ltd., succeeding the late **H. S. Austin.**



Morgan Walker

Walker, a graduate of Oklahoma A. & M. College, went to Venezuela in 1929 as a petroleum engineer with Creole Petroleum Corporation. In 1937 he was transferred to New York as technical assistant to Eugene Holman, then in charge of foreign operations for Standard Oil Company (N. J.). He joined the Bechtel group in 1944 and became general manager of the Venezuelan associate, Compania Bechtel. In 1948 he visited Saudi Arabia for the Bechtel interests in connection with construction of the Trans-Arabian pipe line.

In April, 1949, he opened his own office as a consultant in New York.

•

Dr. Harvey T. Kennedy has joined the staff of the Petroleum Engineering department of the Agricultural and Mechanical College of Texas as distinguished professor of petroleum engineering. Dr. Kennedy received his bachelor's degree in chemistry from Cornell University, and his Ph.D. in physical chemistry from Johns Hopkins University. After service in the Municipal Testing Laboratory, Rochester, N. Y., and in the U. S. Bureau of Standards, in 1930 he joined the Gulf Research and Development Company, where he remained until his present appointment.

•

James M. (Jimmy) Charlton has retired from the Land department of Standard Oil Company of Texas after more than 25 years of service. His last three years were in the company's Houston office, prior to which he served four years in Dallas, 16 years in San Antonio, and several years in West Texas. He was honored with a dinner by fellow workers at the time of his retirement. He will enter the oil business for himself.

•

H. W. Gray has resigned from Tide Water Associated Oil Company to become director and vice president of the Pacific Oil and Gas Development Corporation.

•

Dr. George M. Saunders has been appointed medical director for overseas operations of Socony-Vacuum Oil Company, Inc. Dr. Saunders has been associate medical director of Monsanto Chemical Company and associate professor of preventive medicine and clinical medicine at Washington University School of Medicine.

•

Bruce C. Clardy, former executive of Standard Oil Company (Indiana), has resigned to become an independent operator in Texas.

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Greater exactness in engineering and fabrication of Butler Bolted Tanks make the big difference in the oilfield. With every part die-formed and punched to fit exactly, Butler Tanks can be erected faster and easier—and with assurance that the fit will be oil-tight throughout the tank's long service life.

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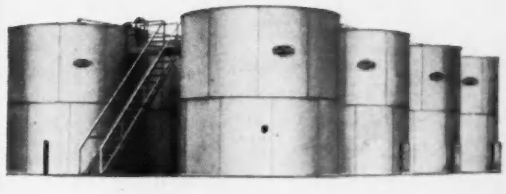

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GREAT BEND, Moss Scranton, Phone 312

MEN IN THE INDUSTRY NEWS

F. A. Jewell, formerly assistant district superintendent at Avoca, Texas, has been named superintendent of the new Winters district of the North Texas division of Humble Oil & Refining Company. The district will include Humble's wells in four producing areas, including the Bronte field.

Others transferred to the new district office are **W. C. Werner,** formerly in the division office at Wichita Falls, district chief clerk; **R. A. Brand,** formerly at Vernon, assistant district chief clerk; **W. E. King,** district clerk, from Pampa; **F. G. Thomas,** district petroleum engineer, from Pampa; **William Thiebaud,** toolpusher, from Hobbs, N. M., and **D. K. Smith,** farm boss, from Means, Texas.

•

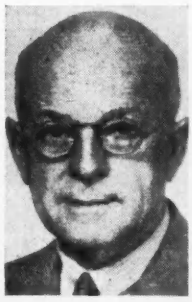
Max C. Eastman has been appointed to succeed the late **Capt. V. H. Wilhelm** as Navy's member on the Operating and Engineering committees for the Elk Hills Unit Plan. Eastman, a graduate of the University of California, has been with the Navy Department as a petroleum engineer for ten years, serving at different times both as a reserve officer and a civilian. Prior to going with the Navy, Eastman was employed by the General Petroleum Corporation.

•

J. R. Vandever has been named general superintendent of the Production department of Sunray Oil Corporation. Vandever has been assistant general superintendent of Sunray's producing activities since he was transferred to the company's Tulsa offices in March, 1948. Prior to assuming his supervisory duties at Tulsa, he was division superintendent of Sunray's North and West Texas division. He has been associated with Sunray since 1930.

•

Joseph E. Pogue, petroleum economist and vice president of the Chase National Bank of the City of New York, was elected a member of the Gulf Oil Corporation's board of directors, and also will serve the company in a consulting capacity.



Joseph E. Pogue

During World War I, Pogue was assistant director, Bureau of Oil Conservation, U. S. Fuel Administration, following which he was associated with the Sinclair Consolidated Oil Corporation as manager of the Department of Economic Research. In 1920 he established his own consulting engineering firm, continuing this endeavor until he joined the Chase National Bank in 1936.

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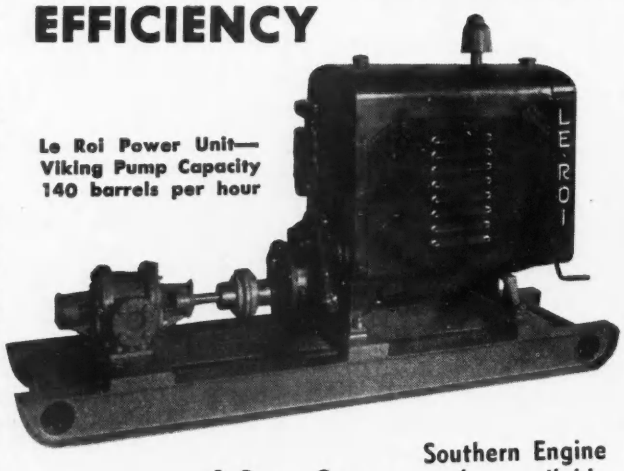
Viking Pump Capacity
140 barrels per hour



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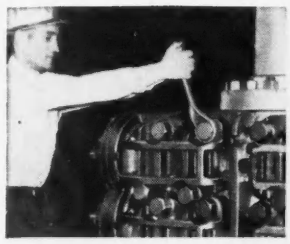
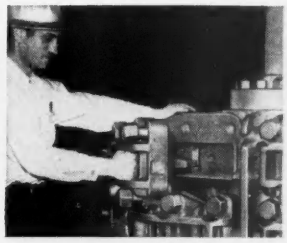
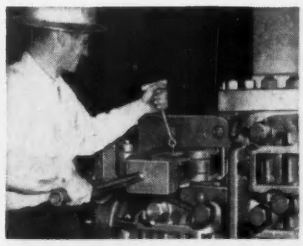


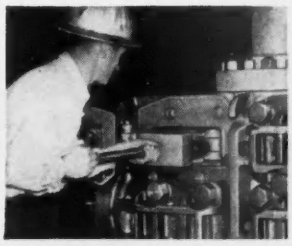
1. Unbolt Two Doors in the side of the Gate. You don't even have to remove the bolts—they remain in the doors where they can't become lost.



2. Swing the Doors Open and pull out the ram assembly. There's nothing to loosen, unlock or disengage. It slides right out.



3. Lift the Rams from the Gate and simply replace the Ram Blocks and rubbers with others of the desired size and type.

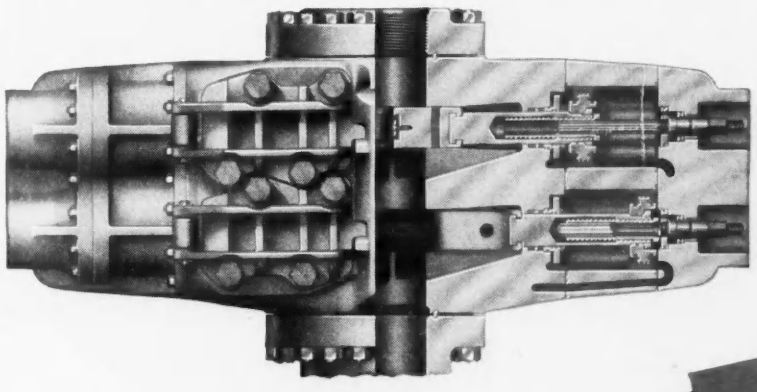


4. Slide the Ram Assembly back into the Gate, close and bolt the doors. Closing the doors automatically aligns Ram Assemblies within Gate.

It's as simple as that—and as fast. And here's another important feature—you can make a complete ram change *whether the pipe is in or out of the hole!*

Best of all the unusual speed and simplicity with which rams can be changed is only one of *many* vitally important advantages that Shaffer engineers—pioneers in the development of high pressure control equipment—have incorporated into the Shaffer Hydraulic Cellar Control Gate. A few of the many other features are outlined at right. But be sure to get the *complete* story before you buy *any* cellar control gate equipment. No other equipment provides so much protection—in such a compact space—with so many operating advancements as . . .

The SHAFFER HYDRAULIC CELLAR CONTROL GATE!



The sectional view above shows how two separate ram compartments are unitized into one compact body. Note the self-draining bottoms of the ram compartments . . . the direct hydraulic drive . . . and the completely enclosed design of the Shaffer Hydraulic Cellar Control Gate!

Write for the new Shaffer 1950 Catalog that gives full details on the Shaffer Hydraulic Cellar Control Gate as well as on other Shaffer products!

See pages 4433 to 4496 of the 1950 Composite Catalog.

Additional unique features in the Shaffer Hydraulic Cellar Control Gate

- **SPACE SAVING COMPACTNESS:** Two separate ram compartments are unitized into one body, yet the *overall* height of the entire Gate, including *both* compartments is *only* 30" even in sizes as large as 13⅜". Smaller sizes even less!
- **COMPLETELY ENCLOSED DESIGN:** All moving parts, including piston rod ram shafts, are completely enclosed within the body of the Gate. No moving parts project from the Gate—nothing to become damaged or wedged by falling objects or loose timbers in the cellar, nothing to become corroded by salt fluids or chemical muds dripping into the cellar. This means greater safety, less maintenance!
- **DIRECT HYDRAULIC DRIVE:** Hydraulic operating cylinders are *directly behind* the rams for direct action, maximum simplicity, greatest safety. No secondary connections between hydraulic cylinders and rams!
- **SELF-DRAINING BODY:** The rams travel on high narrow guide ribs raised above the steeply-sloped bottoms of the ram compartments. Mud and sand quickly drain back into the well—no detrimental accumulations to interfere with free operation of the rams!

These and still other unique features make the Shaffer Hydraulic Cellar Control Gate the outstanding *hydraulic* gate available today. Get full details from your Shaffer representative—or write direct!

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CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
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J. R. McCreary was named to the office of the Crude Oil Purchasing department of Sohio Petroleum Company, with headquarters in St. Louis.

McCreary joined Sohio's Cleveland office as staff assistant in crude oil procurement in January, 1943. He was transferred to the St. Louis office in May, 1945, and became assistant to **J. Frank Wilson,** vice president, in January, 1946. With the establishment of the Crude Oil Purchasing department in December, 1947, all crude oil purchasing activities were centralized in St. Louis and McCreary was appointed assistant manager in April, 1948.

Floyd A. Calvert, general attorney for The Pure Oil Company, Michigan district, has been named the company's attorney and representative at Washington, D. C.

•

L. A. Pyeatt has joined Loffland Brothers Company of Tulsa, and will make his headquarters in Fort Worth. He will be engaged in contact work with oil operators in the Dallas, Fort Worth and West Texas areas.

During the past year, Pyeatt has been vice president of Aeroquipt Sales and Engineering, Inc., Fort Worth.

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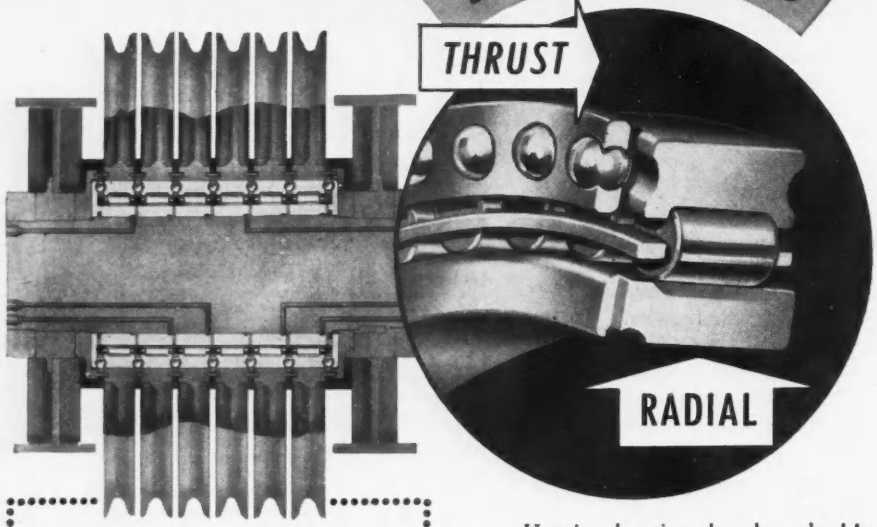
WITH THE HELP OF THIS New Aetna 2-WAY BEARING



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A. Neil Lilley has been appointed general manager of Foreign Operations, Eastern Hemisphere, for The Texas Company. He came with the company in 1933 and has held various positions in this country and abroad. From 1942 to 1945 he served with the U. S. Army Air Forces.

A. Neil Lilley

•

J. B. Webb, formerly division exploration manager for Imperial Oil, Ltd., has been named chief geologist for Anglo-Canadian Oil Company, Ltd., at Calgary, Alberta.

•

Ed F. Aycock, petroleum engineer, and **E. F. Estergren,** geologist, have joined the D. K. N. Oil Company, Dallas, Texas, which was recently organized and operates in North and West Central Texas.

•

M. T. Rathvon, vice president in charge of operations for Argo Oil Corporation, has retired after 31 years with that company and its predecessors.

In 1897 he joined the drilling department of the United Oil Company and later became a drilling contractor, operating in Colorado, Kansas and Oklahoma. In 1919 he became general superintendent of The Western States Oil and Land Company, a predecessor of Argo.

•

John W. Phariss, formerly head of the Records and Statistical Section of the Stanolind Oil Purchasing Company, Tulsa, has been named manager of Deep Rock Oil Corporation's Budget and Statistical department. Phariss is a certified public accountant and obtained his B.S. degree in 1946 and his M.B.A. degree in 1947 from the University of Oklahoma before joining Stanolind.

John W. Phariss

•

Hilliard W. Carey, production manager; **C. A. Nees,** chief production clerk and dispatcher; **W. H. Spencer,** geologist; **D. B. Chamrad,** district production engineer; and **L. M. Stevens,** dispatching engineer of the Production department of Houston Natural Gas Corporation, Corpus Christi, have moved to new offices at 1007 Santa Fe Street in Corpus Christi.

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Here's actual operating proof in oil field service. This FWD is plowing through loose sand to get equipment to location. Yes — work such as this demands going power only four driving wheels can give you. What's more, you know before you buy, because FWDs are proving-ground tested to climb a 6% grade through blow sand 3 feet deep. *No wonder many of the world's leading oil field operators standardize on FWDs — with individual fleets of over 600 units!*

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America's Foremost Heavy-Duty Truck

DEATHS

Daniel Fred Martin, 83, retired head of Land and Lease operations for Standard Oil Company of California in Southern California, died November 26. He joined California Standard in 1910, and was in charge of acquisition of land in Southern California during the discovery of the early major fields in that area. He retired 16 years ago.

•

Julius P. Heil, 73, founder and chairman of the board of The Heil Company, Milwaukee, died November 30. He was a former governor of Wisconsin, and was prominent in civic and humanitarian activities in his state.

L. E. Roberts, 50, Tulsan affiliated with Unit Rig and Equipment Company, died November 28. Before joining Unit Rig he had been with Roxana Oil Company, Independent Oil and Gas Company, and the Waite Phillips interests.

•

Thomas Allan Northrup, president of Northrup Equipment Company, died October 25 in Parkersburg, W. Va.

Allen Whiteside, 55, of Tulsa, former executive assistant to the president of the Sinclair Prairie Oil Company until his retirement in 1940, died November 29 in New Orleans.

•

Dr. Adam Wroblewski, 60, geologist and research engineer, died December 10 at Norman, Okla. A graduate of the School of Mines, Leoben, Austria, he was research scientist for Gypsy Oil Company in Oklahoma, and assisted in organizing the Oklahoma Academy of Science.

•

Dr. J. J. Deaner, 69, dentist and independent Tulsa oil operator, died December 5. In the early 1920's Dr. Deaner opened the Deaner pool of Okfuskee County, Oklahoma, in association with former Oklahoma senator **E. H. Moore** and **H. L. Wirick.** One of his later associates in independent oil dealings was **George B. McCamey,** Fort Worth.

•

Frederick George Bannerot, 74, president of United Oil Company, died December 2 in Pittsburgh. He was also president of United Refining Company; vice president and treasurer of Elk Refining Company; and a director of Emblem Oil Company and Tiona Petroleum Company.

•

Robert C. Engelman, assistant chief engineer for Clark Bros. Company, Inc., Olean, N. Y., died November 30. Engelman joined Clark in 1937 as engineer on a special project, and previously had been with T. R. Dresser Manufacturing Company.

•

Harvey Hardison, 54, manager of the Non-Operated Joint ventures in Texas and New Mexico for Standard Oil Company of Texas, died December 8 at Midland, Texas. Hardison was graduated by the University of California in 1921, with a degree of bachelor of science. He started his geological and engineering career with Standard Oil Company of California at Coalinga, Calif., and came to Texas in 1928.

•

Vernon L. Porter, 63, an employe of The Texas Company for 38 years, died in Houston December 18. Porter had been assistant to the manager of Texaco's Production department for the past ten years. He had been with the department for about 20 years.

•

George W. Stroup, 52, assistant purchasing agent for Tide Water Associated Oil Company at Tulsa, died December 6. Before joining Tide Water, Stroup had been with Oklahoma Producing and Refining Company.

T hree sizes for shallow, medium, and deepest wells

H and lever assures simple operation

O perates perfectly at maximum flow or idling

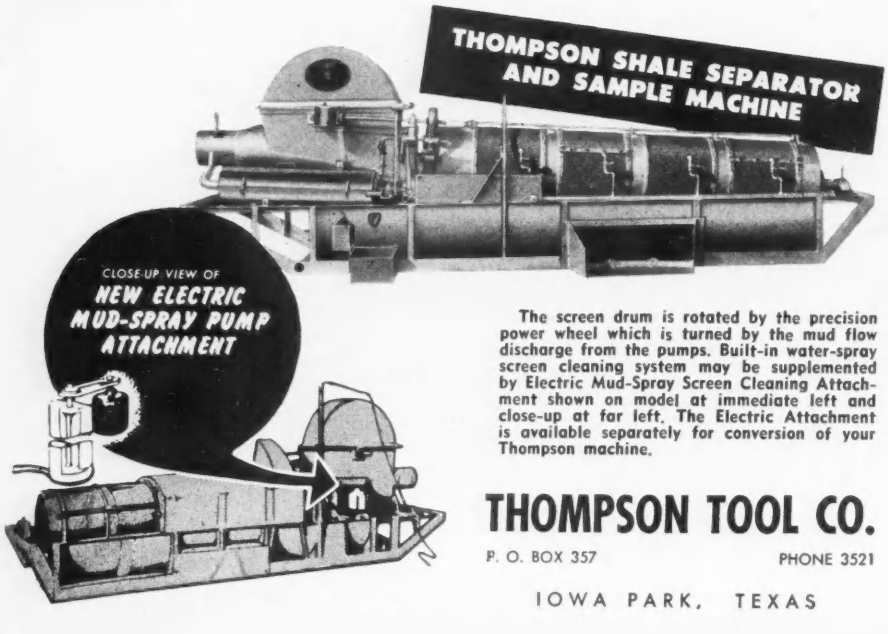
M ore profits - low cost to buy - no cost to operate

P rovides accurate foot by foot cuttings

S ample machine *Provides Accurate Samples*

O nly clean mud goes back into machines

N o abrasives to wear out equipment



The screen drum is rotated by the precision power wheel which is turned by the mud flow discharge from the pumps. Built-in water-spray screen cleaning system may be supplemented by Electric Mud-Spray Screen Cleaning Attachment shown on model at immediate left and close-up at far left. The Electric Attachment is available separately for conversion of your Thompson machine.

THOMPSON TOOL CO.

P. O. BOX 357 PHONE 3521

IOWA PARK, TEXAS

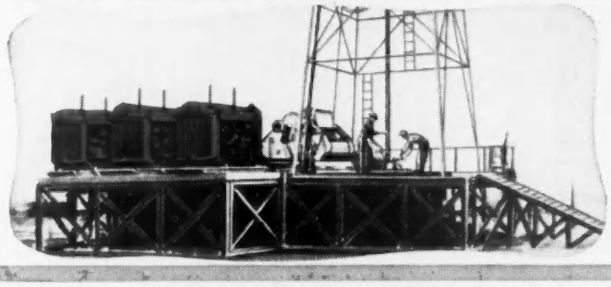
5 FORCEFUL FACTS
ABOUT EFFICIENT OIL PRODUCTION

1 For Smoothing the Way . . .

to drill sites—building roads, leveling sites and hauling in heavy equipment—use International Crawlers. They are tough and ready to handle the hardest jobs, overcoming obstacles of difficult terrain.

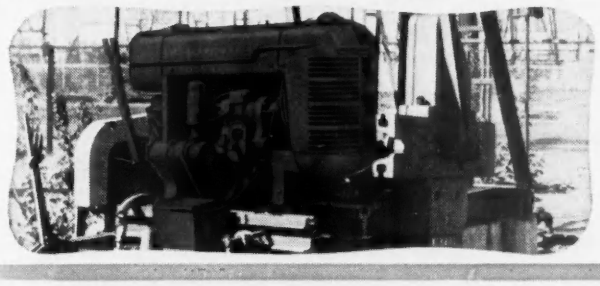
2 For Scooping Out Slushpits . . .

in a hurry use the time-tested workhorse of the oilfields—the International TD-14A diesel crawler. It's compact, easily moved from place to place and powerful enough to do most of the heavy work around the rig.



3 For Drilling Power . . .

you can't beat International Power Units, available in sizes up to 180 net horsepower. Use them to drive generators, rotary tables, draw works and mud pumps, with ease and economy. Whether you use a rotary or cable-tool rig, power it with an International.



4 For Pumping Wells . . .

there is no more efficient or economical power to use than the right size International Power Unit, equipped to burn waste gas. There's a model to match any pump-jack power requirement.

5 For Laying Pipelines . . .

big, medium or small—there are International Crawlers with matched side booms to do the job with speed and economy. No job is too big for Internationals to handle—or too small for Internationals to do economically.

Remember these five forceful facts
when you need oilfield power

INTERNATIONAL HARVESTER COMPANY
Chicago

Hear James Melton on "Harvest of Stars" NBC Sunday

INTERNATIONAL HARVESTER

Standardize on Power that Pays

INTERNATIONAL
INDUSTRIAL POWER

CRAWLER TRACTORS
WHEEL TRACTORS
DIESEL ENGINES
POWER UNITS

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Oil Base Sales Agent Is Named

Core Laboratories, Inc., Dallas, will represent Black Magic oil base drilling fluid, White Magic oil-emulsion mud and mud conditioning products manufactured by Oil Base, Inc., of Compton, Calif. All territories east of California, including Canadian oil fields, will be serviced from Core Lab's 14 offices and eight warehouses. Fields in California, Oregon, Washington and abroad will continue to be served by Oil Base, Inc. The joint announcement was made by George Miller, president Oil Base, Inc., and William Davidson, president Core Laboratories, Inc.

Watching Davidson sign the agreement are Thad Randolph, left, sales manager for Oil Base, and Miller.

Westinghouse Names Deines Manager Of Advertising and Sales Promotion

Harry J. Deines, New York, has been named manager of advertising and sales promotion for Westinghouse Electric Corporation, Pittsburgh. Deines, a graduate in mechanical engineering from the University of Colorado, joined General Electric Company in 1930, and worked in advertising and sales promotion activities until 1944, when he joined the Arthur Kudner Advertising agency as an account executive. He was later account executive and vice president of the Fuller & Smith & Ross, Inc., agency.

Photogeology-Photogrammetry Firm Opens Houston Consulting Offices

Louis Desjardins and P. H. Blanchet have established the firm of Desjardins and Blanchet, consulting photogeologists and photogrammetrists, with offices in Houston.

Desjardins was in charge of photogeology and photogrammetry for Creole Petroleum Corporation in Venezuela, and Blanchet held a similar position with International Petroleum Company in Peru.

National Tube Appoints Bialock as Specialties Division Sales Manager

Harry L. Bialock, manager of sales of National Tube Company at Atlanta, has been promoted to manager of sales of the tubing specialties division, with headquarters at Gary, Ind. He succeeds David T. Marvel, resigned. Charles J. Lundvall, formerly a salesman in the New York district office, has been appointed sales manager at Atlanta.

Unit Rig Announces Changes in Sales and Service Personnel

Wendell H. Messenger, who has been with Unit Rig & Equipment Company, Tulsa, for 12 years, is now sales and service representative in Casper, Wyo. He succeeds Wayne Hughes, resigned.

Sam Ennis has moved to Salem, Ill., to take over Unit Rig's northern district of Illinois, Kentucky, Indiana and Michigan. He has been with the company ten years.

The Houston sales and service position has been assigned to H. C. (Red) Creath, who will headquarter at 2215 Wentworth Avenue, Houston.

IDECO Names George W. Walton as Executive Vice President, Director

George W. (Jack) Walton has been elected executive vice president and a member of the board of directors of International Derrick and Equipment Company. He was formerly vice president in charge of the Machinery and Export Sales division.

W. O. Timberlake

Walton, who joined IDECO in 1944, had previously been a representative of The National Supply Company, serving three years in the U. S. and two years in London. He had also been with Wilson-Snyder Manufacturing Company, Emsco Derrick & Equipment Company as vice president and sales manager, and with Unit Rig and Equipment Company as sales manager.

IDECO also announced the addition of W. O. Timberlake, former general manager of Cardwell Manufacturing Company, to the Technical Service staff, with headquarters in Tulsa.

C. W. Nichols has been appointed manager of the company's new supply store at Snyder, Texas.

TOP EXECUTIVES of International Derrick & Equipment Company who met to plan the 1950 sales campaign are, left to right, Ferguson Barnes, vice president and general manager, Columbus plant; T. D. Collins, vice president, IDECO Supply Stores division; R. R. Bloss, vice president and general manager, Beaumont plant; G. W. (Jack) Walton, executive vice president; J. M. Gardner, president; J. D. McEwen, vice president and general manager, Torrance plant.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

H. Wotkyns

E. M. Gearke

Baash-Ross Company Advances Three To Executive Administrative Posts

H. Wotkyns, formerly district manager of Baash-Ross Company's Northern Mid-Continent division, has been appointed domestic sales manager with headquarters at Oklahoma City. Wotkyns has been with the company 14 years.

R. G. Wolf

E. M. Gearke, who has been district manager of the Rocky Mountain division, has moved to Oklahoma City to manage the Northern Mid-Continent division. R. G. Wolf, who succeeds Gearke as manager of the Rocky Mountain division, was previously sales representative in Kansas. His Rocky Mountain headquarters are at Casper, Wyo.

Jarecki Manufacturing Company Is Made Division of H. K. Porter

Jarecki Manufacturing Company has been consolidated with H. K. Porter Company, Inc., and will now be known as the Jarecki Manufacturing Company division of H. K. Porter Company, Inc.

W. Howard Pape has been elected a vice president of the Porter organization, and will continue in charge of oil field distribution.

J. G. Harrell Becomes Supervisor For Southern Geophysical Company

J. G. Harrell of Fort Worth has been appointed a supervisor for Southern Geophysical Company with headquarters in the Sinclair Building, Ft. Worth.

J. G. Harrell

Harrel was graduated from the University of Missouri in 1923. For the next nine years he was engaged in civil engineering and since 1932, he has done seismograph work both in the field and office for Seismograph Service Corporation, Mid-Continent Petroleum Corporation and Stanolind Oil and Gas Company.

How Fast and Easy You Can String a WECO Snatch Block

When you're working with a WECO Block, you string or unstring it easily and quickly at any time, whether or not there's weight on the line. There's no trick manipulation, no "wrestling" to release or secure the side . . . you simply unscrew a nut, lift the side, insert or remove the line, drop the plate and replace the nut. After placing the line in the sheave, it is not necessary to lift either the weight of the line or the block to secure the side. There's never any need, of course, to reeve the block with the end of the line.

Other WECO features . . . full swiveling forged steel hook, heavy shell plates, forged sheave with accurately gaged, rope-saving groove, heavy hardened and ground sheave pin, "Super Oilite" bearing . . . combine with the time-saving "Drop Side"* to make WECO Snatch Blocks the finest available. Specify them for the ultimate in speed, safety and service. Available with full swiveling hook or clevis in 6", 8" and 10" sizes for wire or manila rope.

*** Patent Nos. 2,235,302 & 2,288,116**

SOLD THROUGH SUPPLY STORES EVERYWHERE

YOUR WECO REPRESENTATIVE can furnish you with helpful information on the use and care of snatch blocks and wire lines. Applied in your operations, this information will effect great savings in time and materials.

WELL EQUIPMENT MFG. CORP.

Subsidiary of Chiksan Company

HOUSTON 1, TEXAS

Exclusive Sales Representative Outside Mid-Continent Area

CHIKSAN COMPANY

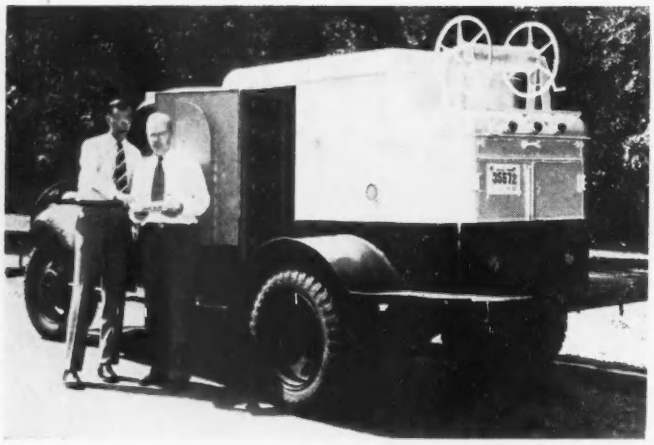
Brea Calif. New York 7

Export Sales: CHIKSAN EXPORT COMPANY, Brea Calif. New York 7

WECO

Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

Seismic Unit Given To Colorado School



The 12-trace reflection seismic recording unit is shown being presented to the Colorado School of Mines, Golden, Colorado, by Seismograph Service Corporation of Tulsa. Making the presentation for SSC is Dr. J. W. Hawkins, vice president (right) and receiving the truck on behalf of the Colorado School of Mines is H. E. Stommel, instructor of geophysics.

The equipment includes a complete operating unit with camera, amplifier, geophones, cables, recording paper, etc., mounted on a Chevrolet truck. It will be used for practical field instruction in geophysical problems related to the exploration for oil and gas.

This is the third unit to be presented by Seismograph Service Corporation to educational institutions in the past two years. Previously a complete unit was given to Koninklijk Nederlands Meteorological Institut, De Bilt, Holland, and early this year a similar unit was given to the Geophysical department of The University of Tulsa.

American Hoist & Derrick Company Appoints General Sales Manager

John E. Carroll has been named general sales manager of American Hoist & Derrick Company, St. Paul, Minn.

Carroll, a graduate engineer from the University of Minnesota, started work for American Hoist in 1937 as a district sales representative. He resigned and was a partner in Harron, Rickard and McCone Company, Southern California, heading the Construction Equipment division until his return to American Hoist.

Bovaird Supply Elects Officers; Will Distribute Gilmer Products

Davis D. Bovaird was elected president of Bovaird Supply Company. Other officers are Frank D. Bovaird, vice president; Roscoe G. Ayers, vice president and general manager of sales; R. M. McMahan, treasurer and secretary; and M. B. Park, assistant secretary.

Re-elected directors are Davis and Frank Bovaird, Ayers McMahan, and A. E. Booth. Raymond E. Batchelor, general manager of stores, was also named to the board.

Bovaird has been appointed distributor for Illinois, Kansas, Oklahoma and Texas of the V-belts, V-belt sheaves, rubber and friction tape manufactured by the L. H. Gilmer Company.

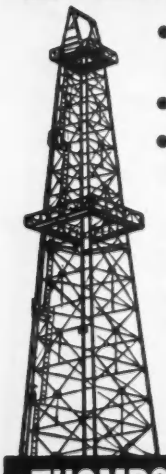
Also announced was the opening of new stores at Snyder, Texas, and Great Bend, Kansas.

Southern Geophysical Appoints Davis West Texas Supervisor

R. E. Davis of Southern Geophysical Company, Fort Worth, has been promoted from party chief to West Texas supervisor.

Davis has been with Southern since the company was organized four years ago and previously was with Stanolind Oil & Gas Company for ten years. He is a member of the Society of Exploration Geophysicists and the Fort Worth Geophysical Society.

THOMPSON-HAYWARD FORMALDEHYDE *Reduces* CORROSION



- Save on Pulling Costs
- Save on New Steel
- Save on Shutdown Time
- Low Cost
- Dependable
- Field Tested

Protect expensive and hard-to-get steel parts from hydrogen sulphide corrosion and corrosive mine and well waters, with Thompson-Hayward Formaldehyde.

Warehouse Stocks Available For Prompt Shipment

THOMPSON-HAYWARD CHEMICAL CO.

DALLAS WICHITA HOUSTON TULSA NEW ORLEANS DENVER SAN ANTONIO

HUNTING FOR OIL?

GEOLOGRAPH

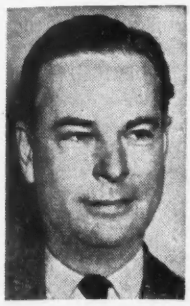
MECHANICAL WELL LOGGING SERVICE CAN HELP YOU!

FOOT BY FOOT, Geograph records lead you to that big pay you're hunting! Your men will do a bang-up job on that well when they have the detailed record made available by Geograph Mechanical Well Logging Service. Send for further details now.

ODESSA, TEX.—WICHITA FALLS, TEX.—BAKERSFIELD, CALIF.
SHREVEPORT, LA.—BATON ROUGE, LA.—CASPER, WYOMING

"TIME WILL TELL"
THE GEOLOGRAPH CO. INC.
P. O. Box 1291 Oklahoma City 1, Okla.

EQUIPMENT and SERVICE SUPPLIERS' NOTES



M. G. McCool

Elmer E. Rubac

American Iron & Machine Elects President, Other Top Executives

American Iron & Machine Works Company's board of directors has elected M. G. McCool, Oklahoma City, president and general manager. J. A. Gray, Houston, was elected chairman of the board. Other officers are Elmer E. Rubac, Oklahoma City, vice president and assistant general manager; V. L. Thomas, Oklahoma City, secretary-treasurer; Cecil Cook, Houston, vice president; and A. J. Farfel, Houston, assistant secretary, Claude L. Griffin, Oklahoma City, was appointed sales manager.

Claude L. Griffin

McCool, who has been with the company 14 years, was previously executive vice president and general manager. Rubac, prior to his present assignment, had been McCool's assistant. Griffin had been assistant sales manager.

Altens Foundry and Machine Names Kansas and Oklahoma Representative

The Altens Foundry and Machine Works, Inc., Lancaster, Ohio, manufacturer of Alten pumping units and other oil field production equipment, has appointed F. L. Radican as district salesman.

F. L. Radican

Radican, who was formerly with The Rollans Elliot Company of Tulsa, will supervise the sales and servicing of Alten equipment in Kansas and Oklahoma, and will have headquarters in Tulsa.

BJ Engineer Wins Award

J. M. Gaylord, chief electrical engineer for Byron Jackson Company, Pump division, received one of *Electrical Manufacturing* magazine's Certificates of Award and a cash prize of $500 for his manuscript on the company's Stuffing-boxless Pump and submerged electrical motor unit.

ACCURATE PIPE CUTS
Quick and Easy

"Anybody does better work with better tools—If they come any better than RIDGID I've never seen 'em."
RIDGID
No. 2 HEAVY DUTY
1/8 TO 2
If this Housing ever Breaks or Distorts we will replace it Free

RIDGID Cutters roll right through all kinds of pipe and conduit

● It's really a cinch to cut pipe extra fast with the popular efficiency-balanced RIDGID cutter. Thin heat-treated tool-steel blade leaves practically no burr. Every cutter factory-tested to make sure it tracks perfectly. Your choice of five sizes to 6" pipe; four-wheel cutters to 4." Choose the favorite of men who know fine tools—buy RIDGID cutters at your Supply House.

RIDGID
WORK-SAVER PIPE TOOLS
THE RIDGE TOOL CO. • ELYRIA, OHIO

Not pictured here are four staff editorial assistants.

. . . and YOU were there, too!

YOU—and the more than 20,000 of our subscribers—were there in December when WORLD OIL's editorial staff gathered at Cherry Valley Ranch in the quiet hill country of West Texas to plan what we will do for YOU in 1950.

YOU were with us four days, from the moment that Ray L. Dudley, our publisher, opened the conference with a challenge . . . **No magazine is yet realizing its full responsibility, its privilege of service, he declared, and issued a renewed determination that none shall try harder to do a job for YOU than we of WORLD OIL.**

YOU were represented by a group of leading consultants from the oil producing world who took leave of their important affairs to participate in the sessions pertinent to *their* work and YOURS. A major company drilling engineer, two drilling contractors, two petroleum engineers with major oil companies, an important independent producer and two executives with major pipeline operating companies contributed authoritative advice and suggestions from the storehouse of their experience. They pointed out new methods, trends, and developments which they thought YOU'ld be interested in reading about in WORLD OIL. They weren't at all backward in suggesting improvements to WORLD OIL in order that YOU may be benefited in the future.

YOU were there, too, through the replies received to our recent cross-section survey of 2200 subscribers. In this survey subscribers told us what they like about WORLD OIL, and in some cases what they don't like. Each one of hundreds of articles suggested by readers was discussed.

YOU were there in a commanding way as those articles which seemed to be of greatest interest to you were assigned to a staff member to write, or to have written by an outside expert.

YOU—we firmly believe—will see the results of this conference in the next 12 months. We thank YOU for being there. YOU will be just as influential in the planning of WORLD OIL's editorial throughout the year when we gather at frequently-held "progress" conferences.

Boyles Galvanizing Company Plant To Handle Jobs in Mid-Continent

Boyles Galvanizing Company has been established in Tulsa, with W. M. Boyles as president and W. A. Brown, vice president. Boyles previously had been manager of the Rogers Galvanizing Company plants in Tulsa and Houston, and Brown had been superintendent of Rogers' Tulsa plant.

The Boyles plant will employ 50 workers to handle galvanizing jobs for concerns in the Mid-Continent states and others as far as Pittsburgh and West Virginia. The plant is housed in a building purchased from National Tank Company.

Loffland Elects Vice Presidents To Head Operations and Contracting

B. B. Smith has been elected vice president in charge of operations, and T. W. Wheeler has been named vice president in charge of contracting for Loffland Brothers Company.

Smith, who has been with the company 15 years, was formerly vice president in charge of the Houston division. Before joining Loffland, he was with Meade Brothers, Inc., J. E. Mabee, and Arrow Drilling Company.

B. B. Smith

T. W. Wheeler

Wheeler was general superintendent of the Core Drill division of Phillips Petroleum Company before resigning in 1939 to form a drilling company. In 1943 he joined Kerr-McGee Oil Industries, and before joining Loffland last year, was assistant to the vice president in charge of drilling.

George Mallory, formerly superintendent at New Iberia, La., has been made general superintendent in charge of the Houston division. J. E. Cockburn succeeds Mallory at New Iberia.

Frye Is Appointed Manager of Republic's Dallas Sales Office

E. M. Frye has been appointed manager of the new Dallas district sales office of Republic Supply Company. He is in charge of the Fort Worth area as well as the area previously served by the Dallas office.

Frye has been with the company since November, 1943, serving until now as field representative at Dallas.

Transfer of the Republic store from McLeansboro, Ill., to Fairfield, Ill., a move of 35 miles north, has been announced. W. E. Poore, who managed the McLeansboro store, will be store manager.

A NEW DIESEL repair shop at Odessa, Texas, has been added to the service network of Cummins Sales & Service, Inc. J. T. Calnon is service manager and L. T. Troutz is shop foreman.

PARAFFIN'S NO PROBLEM

when your sucker rods are equipped with HUBER SCRAPERS

Paraffin can't accumulate in the tubing when your sucker rods are equipped with Huber Scrapers. NO PARAFFIN . . . NO TROUBLE . . . NO REMOVAL COSTS!

Huber Scrapers, shrink-fitted to new or used sucker rods, scrape paraffin from the tubing wall as the string rotates and reciprocates. This constant scraping prevents paraffin accumulation . . . eliminates paraffin removal.

Huber Scrapers quickly pay for themselves. Wells requiring paraffin removal every week or ten days have been on production for months without paraffin trouble after Huber Scrapers were installed.

If paraffin's a problem, install Huber Scrapers. Write for descriptive bulletin.

HUBER ROTATING ROD HANGER

This rod hanger rotates the rod string a fraction of a turn on each reciprocation. The horizontal teeth on the turn table are engaged by two ratchet levers which are actuated by a flexible steel cable attached to the walking beam. On each reciprocation the levers move the rod string a fraction of a turn.

SOLD THROUGH SUPPLY STORES

J. M. HUBER CORPORATION
P. O. BOX 831 BORGER, TEXAS

HUBER
PARAFFIN SCRAPERS
SCRAPE AS THEY ROTATE AS THEY RECIPROCATE

Bethlehem Representatives Promoted; Field Personnel Changes Announced

J. W. Strickland, field representative for Bethlehem Supply Company, Elk City, Okla., has been promoted to store manager, with P. W. O'Brien as his assistant.

R. H. Schlottman, Jr., former field representative at the Hobbs, N.M., store, has been transferred to Corpus Christi in the same capacity. B. K. Smith, formerly of Corpus Christi, has been transferred to Snyder, Texas, and promoted to store manager. H. G. Nelson, field representative, has been transferred from Alice, Texas, to Corpus Christi.

R. P. Finger, former floorman at Alice, has been promoted to field representative. L. F. Ritchie, formerly service representative in the Field Service department, has been transferred to the Sales department as field representative at Odessa, Texas. B. M. Quigley, field representative at Odessa and Sundown, Texas, stores, has been transferred to Hobbs.

D. S. Counsil, formerly of the Tulsa general office, has moved to Snyder as field representative. C. A. Ritchey, formerly a floorman at Cisco, Texas, has been promoted to assistant store manager at Cisco.

RIGHT NOW.... YOU CAN HAVE THE STURDYBILT HOUSES YOU NEED

Order today and get quick delivery of the STURDYBILT houses you need. Homes, warehouses, tool houses or any other buildings can be delivered and erected in record time. Write today for information.

PREFABRICATED 30 Years HOME MANUFACTURER

MANUFACTURERS OF SPECIAL MILLWORK; DISTRIBUTORS OF JOHNS-MANVILLE BUILDING MATERIALS; CURTIS WOODWORK

STURDYBILT

SOUTHERN MILL & MANUFACTURING CO.

Tulsa, Oklahoma

Prefabricated, Demountable Houses

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STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125-45 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

Republic Supply Names Machinery Sales Manager at Houston Office

Republic Supply Company appointed Robert (Bob) Chenoweth as manager of machinery sales, with headquarters in Houston.

Robert Chenoweth

Chenoweth has been engaged in the sale of machinery to the oil industry since 1929, at which time he started selling pumps in the Mid-Continent territory following graduation in mechanical engineering from Purdue University. Since 1938 he has been located in Houston, and has represented several of the large machinery accounts in the Gulf Coast and Mexico.

Nowlan & Associates Incorporate Appraisal Firm in Evansville

The firm of Harry Nowlan & Associates has been incorporated at Evansville, Ind., to service oil loans for operators by making bankers' appraisals of oil reserves which may be used as collateral.

Officers of the corporation are Harry H. Nowlan, president; Clarence J. Priegel, vice president; Mrs. Marshall Evans, secretary-treasurer.

Cummins Promotes Ellis and Zugar In Service and Sales Departments

Cummins Sales & Service, Inc., has promoted Earl G. Ellis to general service manager and A. C. Zugar to sales engineer. Ellis, who has been with the company since 1941, was formerly ex-

A. C. Zugar

Earl G. Ellis

port service manager at Caracas, Venezuela. He will headquarter in Ft. Worth.

Zugar joined the firm in 1946, and has been a specialty salesman at Odessa, Texas.

Wheatley Equipment and Supply Opens Headquarters in Alberta

Wheatley Equipment and Supply Company, an affiliate of Frank Wheatley Pump and Valve Manufacturer, has established headquarters at Edmonton, Alberta.

Officers of the firm are Frank Wheatley, Jr., president; Gus Baker, Jr., vice president; and Glen Taylor, manager. Taylor has been with the Wheatley organization 22 years.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

George F. Noltein

Harvey W. Hanners

Research Director, Chief Engineer Are Appointed by National Supply

George F. Noltein has been appointed director of research of the Superior Engine division, Springfield, O., of The National Supply Company. Harvey W. Hanners has been named to succeed Noltein as chief engineer.

Noltein has been with the Superior Engine division since 1927, and has been chief engineer since 1937. Hanners, who has been with the division since 1941, has been assistant to the chief engineer for the past two years.

McCullough Tool Company Appoints Schaller to Sales Engineer Staff

McCullough Tool Company has appointed Herman E. Schaller to its staff of sales engineers. Schaller was formerly division sales manager of the Rocky Mountain - Mid - Continent division of Eastman Oil Well Survey Company.

Schaller received his master's degree in petroleum engineering from the University of Southern California, and was a lecturer in the college of engineering.

Wheatley Pump & Valve Appoints O'Connor Export Representative

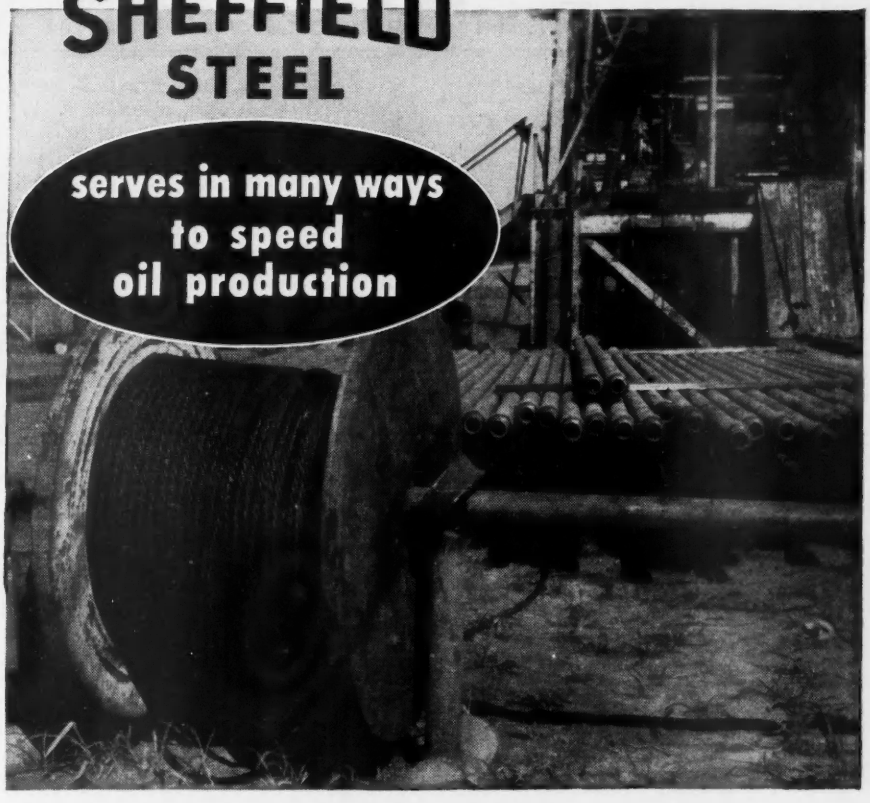
D. T. O'Connor, formerly with Edward Carter, has formed his own company and has been appointed to represent Frank Wheatley Pump & Valve Manufacturer products in foreign markets. O'Connor, whose offices are in New York City, also represents Shaffer Tool Works, M. J. Crose Manufacturing Company, Mayhew Machine Company, and Drilling & Service, Inc.

D. T. O'Connor

Guelph Engineering Will Handle Kerotest Products in Canada

Kerotest Manufacturing Company, Pittsburgh, announced that its cast steel products will be manufactured and distributed in Canada by Guelph Engineering Company, Ltd., Guelph, Ontario.

The oil field specialties will be marketed as Acme-Kerotest products.



From exploration to completion, Sheffield steel in its many various forms and specifications is widely used in the manifold tools and equipment of oil production. Strategically located in the heart of America's greatest oil production area, Sheffield Steel mills are geared to the production of oil country steel. Manufacturers and distributors rely upon this nearby source of supply to help them speed deliveries to the fields.

This oil industry steel is made in hundreds of different types and shapes to exact specifications in Sheffield mills at Houston and Kansas City and supplied to manufacturers of oil field equipment and steel products in semi-finished and finished form. This close link of co-operation between Sheffield steel making and the oil field supply industry assures the oil country that the steel it uses meets the most exacting requirements.

Carbon and Alloy Steel, Ingots, Blooms, Billets, Plates, Sheets, Merchant Bars, Steel Joists, Structural Shapes, Reinforcing Bars Welded Wire Mesh, Wire Products, Wire Rods, Fence, Spring Wire, Nails, Rivets, Grinding Media, Forgings, Track Spikes, Bolt and Nut Products

SHEFFIELD STEEL
CORPORATION
HOUSTON KANSAS CITY TULSA

DISTRICT SALES OFFICES: Chicago, Ill.; St. Louis, Mo.; Des Moines, Ia.; Omaha, Nebr.; Wichita, Kans.; Denver, Colo.; Oklahoma City, Okla.; Dallas, Tex.; San Antonio, Tex.; Lubbock, Tex.; El Paso, Tex.; New Orleans, La.; Shreveport, La.

Edward Opens New Laboratories For Steel Valve Research Work

New metallurgical, physical, and chemical laboratories have been recently completed for Edward Valves, Inc., East Chicago, Ind., and are now in operation. These Edward laboratories are devoted exclusively to steel valve research and the problems related to the manufacture of steel valves.

Equipment has been acquired from Great Britain, Switzerland, Sweden, the Netherlands, France, Germany, Austria, and other countries as well as the U. S. Many machines in these laboratories were built to original Edward designs for special steel valve research.

The new laboratories almost triple previous Edward research facilities. Especially constructed rooms house stress analysis and creep testing equipment with controlled temperature and humidity.

McCullough Names District Manager

G. A. Shidell, former manager for McCullough Oil Tool Company at Guymon, Okla., has been transferred to Oklahoma City as district manager.

B. M. Baker

R. H. Hinkson

Engineering Laboratories Announces Changes in Executive Personnel

Three appointments to new administrative positions in Engineering Laboratories, Inc., Tulsa, have been announced.

Kenneth R. Kennedy

R. H. Hinkson has been named sales manager. He formerly was sales engineer covering the eastern half of the country. Hinkson attended the Chicago School of Business and the University of Virginia. For 11 years prior to entering military service in June, 1942, he was vice president and general manager of Hinkson Service, Inc., dealing in steel construction and electrical engineering. Hinkson has served in various executive capacities of the U. S. Junior Chamber of Commerce and various advertising organizations.

Kenneth R. Kennedy has assumed the position of manager of the plant at Garland, Texas. He went to E. L. I. in 1946 as a designer and draftsman.

B. M. Baker, now engineering manager, joined the company in 1941 as an engineer. From July, 1942, to May, 1945, he served with the Air Corps and Army Air Forces as inspector and investigator of manufacturing procedures. He returned to E. L. I. as chief mechanical engineer and held that position until his recent appointment.

Earl W. Pughe Joins Wheland As Manager of Manufacturing

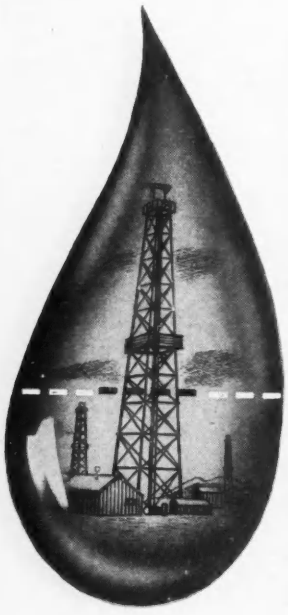
Earl W. Pughe

Earl W. Pughe has joined The Wheland Company, Chattanooga, Tenn., as manager of the Manufacturing division.

Pughe was with the Chevrolet division of General Motors Corporation for 22 years, during which time his duties included management of three Chevrolet plants. Prior to joining Wheland, he had been assistant to the president of the Dana Corporation, Toledo.

First in

CANADA'S OIL FIELDS



The Royal Bank of Canada can answer your questions about Western Canada's fabulous oil development whether you are interested in oil financing in any of its aspects or wish sound advice on establishing business connections in Canada.

The Royal Bank has had branches in Canada's oil fields since the earliest days. Our branch in Turner Valley was opened in 1928 — in Leduc, we opened just one day after the first producing well was completed— in Devon and Redwater, our branches opened last spring. So closely identified has this bank become with Canada's oil development that it has become known as the "R-Oil."

Please address your enquiries to—
E. B. Durham, Supervisor,
The Royal Bank of Canada
Calgary, Alberta

CANADA'S "OIL" BANK
See the Royal about Canada's oil

55 Branches in Alberta, the "oil" province. Over 720 branches in Canada, the West Indies, Central and South America. New York, London, and Paris. Head Office, Montreal.

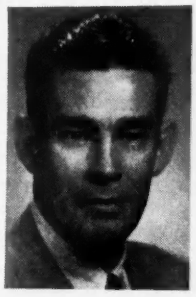
ASSETS EXCEED $2,222,000,000

THE ROYAL BANK OF CANADA

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Ideco Appoints Mills Manager Of Columbus Division Products

Kenneth N. Mills has been appointed product manager of oil field sales for International Derrick and Equipment Company. He will correlate the work of the Columbus division's engineering, production, and quality control departments and give technical assistance to the company's oil field sales divisions.



Kenneth N. Mills

A graduate of The Rice Institute, Houston, Mills joined American Manufacturing Company of Texas in 1934 and was chief engineer when he left in 1940 to accept a similar position with the Tulsa branch of Bethlehem Supply Company. In 1944 he became works manager of Texasteel Manufacturing Company, Fort Worth. After the war, he joined Emsco Derrick & Equipment Company, Houston, as assistant chief mechanical engineer.

Baker Export Service Engineer Travels to Foreign Oil Fields

Ben E. Mater

Ben E. Mater, export service engineer for Baker Oil Tools, Inc., is on a trip to European and Asiatic oil fields, a journey that will involve about 40,000 miles of air travel. He will consult with oil operators in the Netherlands, France, and other areas in Europe, and most of the major fields in the Near, Middle and Far East.

Mater has been with Baker for the past three years in field servicing work in the U. S., Venezuela and Colombia.

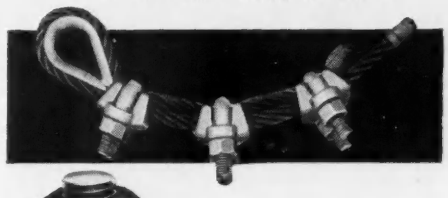
Jas. P. Marsh Corporation Announces Sales and Manufacturing Changes

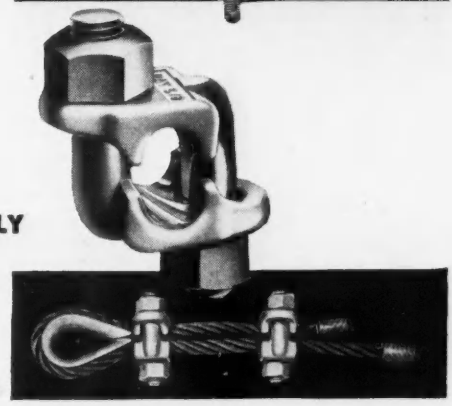
Jas. P. Marsh Corporation announced that sales of the newly-acquired Electrimatic line of refrigeration control valves and regulators will be handled by "The Electrimatic Company," and sales of Marsh pressure gauges, dial thermometers and related products will be handled by "Marsh Instrument Company." Each organization will be designated as "sales affiliate of the Jas. P. Marsh Corporation."

Brewster Names Official

A. Olin Price has been appointed assistant general manager for the Brewster Company, Shreveport.

AVOID THE "FINGER-PINCH"



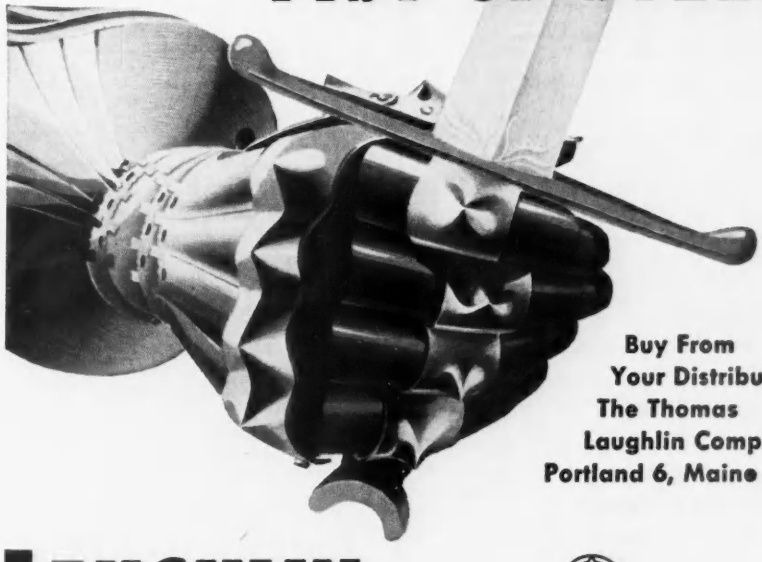


ONLY LAUGHLIN "FIST-GRIP" SAFETY CLIPS

OFFER YOU ALL THESE SAVINGS:

- Fewer clips required . . . money saved
- No crimped, bowed rope . . . rope saved
- Fewer rope breaks . . . accidents saved
- Easy to put on . . . time saved
- Can't be put on wrong . . . accidents saved
- No battered threads . . . bolts saved
- No special wrenches . . . tools saved

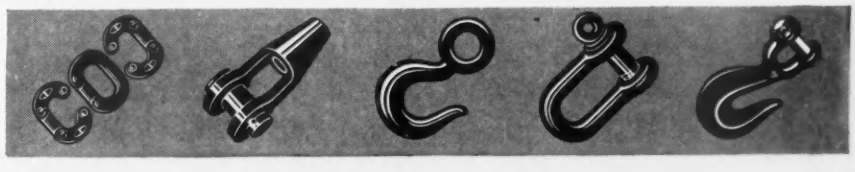
Grip your rope with a FIST OF STEEL!



Buy From Your Distributor. The Thomas Laughlin Company, Portland 6, Maine

LAUGHLIN

THE MOST COMPLETE LINE OF DROP-FORGED WIRE ROPE AND CHAIN FITTINGS



WORLD OIL'S Trading Post

CLASSIFIED ADS

SERVICES · PERSONNEL · USED EQUIPMENT

RATES: Regular Classified (undisplayed) set in this size type: 10 cents per word. If Box Number is to be used count an additional six words. Replies forwarded without charge. Situation Wanted: 5 cents per word. Display advertisements, set in suitably larger type with ruled border: $9.00 per column inch per insertion. Situation Wanted: $4.50 per column inch. All classified ads payable in advance. 10% Discount if 3 or more insertions are ordered at one time. COPY DEADLINE: 5th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

■ ROTARY equipment almost new, only used few days, 1800' PK rods, Drill collar 30'x4¼" with 3½" box, King water swivel 1¼", PK slips, hoist plugs, overshot. Complete outfit $4500 or will divide. We handle new and used spudders, rotaries, core drills, pipe, tools, cable. Fishing tools and equipment rented. Pressey & Son, Pueblo, Colo.

MACHINE TOOLS FOR SALE

5 Bullard Vertical Turret Lathes, 42" tables; 5 Bullard two-head Maxi-mills, 42" tables. All in first class usable condition, complete with motors. Also other machine tools.

The Locomotive Finished Material Co.
Atchison, Kansas

Will consider leasing several 80,000 barrel steel tanks for sweet crude storage at Mexia, Texas.

We also have steel storage tanks for sale as follows:

7—55,000 bbl., Maud, Oklahoma
15—80,000 bbl., Hominy, Oklahoma

For further information write Stanolind Oil Purchasing Company, Attention L. M. Jones, Box 591, Tulsa, Oklahoma.

FOR SALE NEW PIPE

420 Ft. 12" Std. 49.56# ⅜" wall
340 Ft. 8" extra strong 43.38# ½" wall
New seamless plain end pipe, low price.
Exner-Dodge, Inc., Coffeyville, Kansas.

FOR SALE

Complete equipped machine shop in operation in South Texas suitable for the manufacture of oil field or other heavy type equipment. Lathes from 6" to 60", Milling Machines, Radial Drills, Shaper, Key Slotter, Boring Mill, New Lodge & Shipley Hollow Spindle, Planer, Welding and other equipment. $15,000.00 will handle, balance in 10 years. Address: Box 65W, c/o World Oil, Houston, Texas.

Power barge, steel, 28'x94'x10', steel house, equipped with three 9x12 8-eye National Superior diesels and one LI-600 Cummins diesel, with generating capacity of 1050 KW. All necessary auxiliary equipment. Located LaPorte, Texas. For inspection contact W. Teer, Purchasing Department, Humble Oil & Refining Company, Houston, Texas.

SITUATIONS WANTED

■ GEOLOGIST—3 years experience in stratigraphy and micropaleontology, B.A. degree and one year of graduate study. Address: Box 64W, c/o World Oil, Houston, Texas.

■ Petroleum Engineer, 24, single, graduating from large Southwestern college in February desires employment in: engineering department, oil production, appraisal, or research and design work Experience includes military pipelines and summers in oil and gas fields. References. Will arrange for interview. Address: Box 66W, c/o World Oil, Houston, Texas.

Experienced Office and Credit Management, Purchasing Sales, Personnel and Administrative Work. Industrial and Oil Field Supplies. Presently employed in Houston but willing to move. Seek greater responsibility and opportunity. Excellent references. Write Box 67W, c/o World Oil, Houston, Texas.

We are interested in capital and technique for the proper development of large and promising shallow oil field in Jarahueca, Cuba. A visit to the field would result most convincing. Write: Cia., Perforadora de Santa Clara, S. A., 158 Morro St., Habana, Cuba.

NOTICES

■ Potential oil land for lease, 300 yds. from 3700 ft. producing well. Want development. Write Frank Stanush, 1040 Chicago St., New Braunfels, Texas.

ATTENTION

Well established oil well drilling contractor desires to manage and supervise: Individual's, group's, small or medium-sized oil companies' drilling, production and operating problems in Central and Western Texas, and New Mexico. Personal interview by appointment is desired.

Makin Drilling Company
Box No. 131 Phone No. 131
Hobbs, New Mexico

LEASES, DRILLING, ACREAGE, ETC.

■ Will invest in Producing, semi-proven or wildcat royalties. Write details Box 546, Thibodaux, La.

HELP WANTED

Wanted CHIEF ENGINEER

—for major well-known manufacturer of well head controls, plug and gate valves, and other drilling and producing equipment for the oil industry.

Engineer must have degree, experience, reputation and record of successful accomplishments in actual designing and development. Should now be employed.

All inquiries will be kept confidential. Reply giving full details of experience, personal status, expected compensation and a recent photograph. Address: Box 68W, c/o World Oil, Houston, Texas.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Republic Supply Company Appoints Roller General Sales Manager

John S. Roller has joined Republic Supply Company as general manager of sales. He formerly was assistant sales manager of the Birmingham district for Republic Steel Corporation. Roller served as a lieutenant colonel in the Army in World War II.

John S. Roller

Don L. Collins, formerly executive vice president and general sales manager, continues as executive vice president.

Guiberson Assigns Representatives In Houston and West Texas Areas

R. W. (Ace) Elliott, who was formerly with Hughes Tool Company, Oil Center Tool Company and Hughes Supply Company, Ltd., has been appointed sales representative for The Guiberson Corporation at Houston.

Dolton L. Moss, formerly store manager for Jarecki Manufacturing Company at Odessa, Texas, has joined the Guiberson sales staff and will be located in the West Texas territory.

Foreign Relations Representative Joins Independent Exploration

F. L. Cuilty has joined the staff of Independent Exploration Company, Houston, as foreign relations representative for Latin America. He will headquarter in Mexico City.

F. L. Cuilty

Cuilty's association with the petroleum industry includes work with the Guaranty Trust Company of New York and with Doheny interests in Mexico, where he was assigned to the Huasteca Petroleum Company and the Mexican Petroleum Company of California. Later he joined Standard Oil Company (N.J.), serving in New York and London, and specializing in Latin American business.

Prior to the outbreak of World War II, Standard Oil Company loaned Cuilty to the U. S. government to serve on the Evacuation Commitee in London, the Petroleum Supply Committee for Latin America in New York, and the Bunker Control Committee in Washington.

After Pearl Harbor Cuilty was commissioned as lieutenant commander in the U. S. Navy. After his release from the Navy, he returned to Mexico where he engaged in private business, until joining Independent Exploration Company.

New Books, Maps and Movies

Field Development Yearbook

"Oil and Gas Field Development in United States, 1948" reviews geological and geophysical prospecting, land and leasing activities, wildcat exploration, proven field development, oil and gas production, pipe line and refinery operations. Compilation of the yearbook was directed by R. C. Brown, district landman, The Union Sulphur Company, Inc., editor-in-chief, and E. J. Raisch, assistant editor. Statistics for 40 states are given in the 902-page volume.

Included in the yearbook are papers on "Petroleum Development in United States 1948," by Bruce Scrafford, consulting geologist; "Exploratory Drilling in 1948," by Frederic H. Lahee, research counselor, Sun Oil Company; and "Supply, Transportation, and Disposition of Crude Oil in U. S.," by M. G. Langhorne, division manager, Phillips Petroleum Company.

National Oil Scouts and Landmen's Association, Austin, Texas.

Offshore Developments

Literature available on deep water petroleum operations is summarized in "Offshore Petroleum Developments," a bibliography compiled by Emory N. Kemler, Division of Oceanography and Meteorology of the Southwest Research Institute.

The bibliography includes material published in leading petroleum papers relative to operations in the Gulf of Mexico, Lake Maracaibo, off the California coast and other marine areas.

Division of Oceanography and Meteorology, Southwest Research Institute, 312 Oil and Gas Building, Houston.

Physical Principles

Physical principles and facts underlying the mechanics of oil production are discussed in "Physical Principles of Oil Production," by Dr. Morris Muskat, director of Physics division, Gulf Research and Development Company.

The author correlates laboratory theories and field observations of actual oil field performance. Theories of ideal performance are analyzed in detail, to serve as foundations for interpretation.

Examples from actual oil field operation demonstate the basic characteristics of the various types of producing mechanism and operation.

The 922-page volume is illustrated with graphs and charts.

Book Department, Gulf Publishing Company, P. O. Box 2608, Houston, Texas, $15.

Ohio Pipe Lines

A seven-color map of the oil and gas pipe lines in Ohio, drawn to the scale of one inch equals six miles, has been prepared by the Oil and Gas section of the Ohio Geological Survey. The gas portion contains names of utility companies, size, number and ownership of transmission lines, number of consumers, points of distribution, compressor stations, underground gas storage areas, and gas lines entering the state.

The oil section includes location of refineries, their capacity, principal refined products, crude and products transmission lines, direction of flow, compressor stations, and large storage terminals.

The base map shows county, township, city, railroad and drainage data.

Oil and Gas Section, Division of Geological Survey, Department of Natural Resources, Columbus, O., $1.50.

Industry Handbook

Illustrated with sketches and drawings, the booklet "Your Industry and Mine" was written primarily for men and women who work in oil. In simple, non-technical language, it supplies them with a thumbnail understanding of the industry, its history and the progressive policies and operations which have made it one of the keystones of the nation's economy.

J. A. McNally, American Petroleum Institute, 50 West 50th Street, New York 20, N. Y.

Type "XV" (Extra Volume) King Swivels

For Circulating Large Fluid Volumes

Be Sure IT'S A KING *Be Safe*

Type "XV" King Swivels are designed specifically for drilling conditions where the circulation of greater quantities of drilling mud is required than can be handled by conventional models of small swivels.

In addition to oversize watercourses, King Type "XV" Swivels provide many exclusive features that make them the first choice everywhere for Water Well Drilling, Geophysical Drilling, Working Over, Drilling Shallow Oil Wells, Core Drilling, Drilling in and Coring with Reverse Circulation.

Check these outstanding advantages you get with King Type "XV" Swivels:

- OVERSIZE WATER COURSES assure Large Fluid Volume.
- MOULDED RUBBER PACKINGS ELIMINATE the stuffing boxes.
- HARDENED WEAR-BUSHINGS eliminate the washpipes.
- THE PACKING AND WEAR-BUSHINGS can be renewed within a very few minutes without removing any other part from the swivels.
- ANGULAR-CONTACT BALL BEARINGS provide ample thrust capacity and insure radial stability.
- ALLOY STEEL CONSTRUCTION assures safety with minimum weight.
- SHORT, COMPACT DESIGN requires less room in the derrick.
- STREAMLINED—no projections to "hang up."
- CLOSED HOUSING PROTECTS THE BEARINGS.
- LUBRICATION, of BEARINGS, is by means of a grease gun.

This swivel fulfills a long felt need of the well drilling fraternity.

See your latest Composite Catalog for other King Oil Tool products.

KING OIL TOOLS

210 TERMINAL STREET PHONE WO-8013

HOUSTON 20, TEXAS

EXPORT: R. S. STOKVIS & SONS, INC.

17 BATTERY PLACE, NEW YORK 4, N. Y.

IT'S SAFE TO BET ON THIS TEAM

O'Bannon Rod Hooks and Elevators make a rod pulling team you can depend on. Both are safe and easy to handle, and both are "bull-strong"—made of alloy electric steel correctly heat treated for strength and toughness.

ROD HOOKS

Safe, because the hinged latch stays locked across the hook opening until released by the operator. Free swiveling on a large ball-bearing, fully enclosed to retain grease and keep out dirt.

Two types—Regular and Spring type, both available with or without guard.

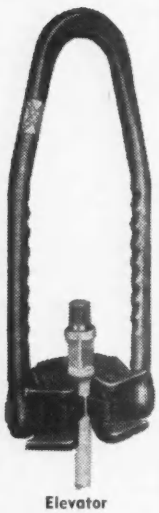
Regular Rod Hook

ELEVATORS

Bodies carefully machined to fit the rod taper—no sharp edges to damage the rod and no plates to come loose.

Sizes available for all standard sucker rods and polished rods and for ¾" and 1" plain and upset tubing.

Each size of rod elevator will also accommodate the next smaller size of rod.



Elevator

API Rated Capacity (¼ of breaking load as determined by actual pulling test to destruction.)

Hooks

Regular .....33,000-lb.
Spring Type .....34,000-lb.

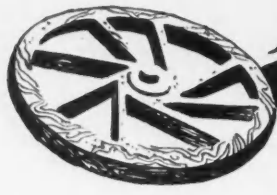
Elevators

Regular .....31,000-lb.
Milelift .....38,000-lb.

You're sure of a safe and speedy rod job if you use O'Bannon Hooks and Elevators.

Sold by Supply Stores

WALTER O'BANNON COMPANY
TULSA 1, OKLAHOMA



SQUEAKS from the BULLWHEEL

Know-How

One of the greatest marksmen of the FBI was passing through a small town and everywhere he saw evidences of amazing shooting. On trees, on walls, on fences and on barns were numberless bullseyes with the bullet hole in the exact center. He asked to meet the person responsible for this great marksmanship.

The man turned out to be the village idiot.

"This is the most wonderful marksmanship I have ever seen," said the FBI man. "How in the world do you do it?"

"Easy as pie. I shoot first and draw the circles afterward."

Juggling Act

An Irishman, inviting a friend to his wedding anniversary, explained how to find his apartment. "Come to the seventh floor," he said, "and where you see the letter 'D' on the door, push the button with your elbow, and when the door opens put your foot against it."

"Why do I have to use my elbow and my foot?" asked his friend.

"Well for Heaven's sake! You're not coming empty-handed, are you?"

The Full Treatment

"Have you ever been X-rayed?"

"No, suh, I ain't ever been X-rayed, but I'se been ultra-violated."

Hunting Season, Maybe

A bald-headed gent stood pensively before the life-sized painting of a curvaceous damsel, clad only in a few strategically placed leaves.

"Waiting for autumn?" asked his wife, acidly.

Promised Land

A very satisfied man arrived at the gates of Heaven and asked for admission. "Where are you from?" asked the attendant.

"California."

"Well, you can come in—but you won't like it!"

The Way to a Man's Heart

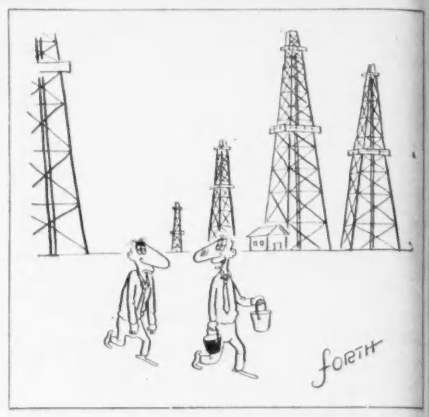
Missionary: "Do you know anything about religion, Chief?"

Cannibal: "Well, we got a little taste of it when the last missionary was here."

The Ghost Walks

Census-taker, viewing Mandy and her six tots with a puzzled frown: "I don't understand you," he said. "Did you say your husband died six years ago?"

"Yessuh," she replied emphatically. "He died, but I didn't."



"O. K., so we didn't strike oil—look at all the worms I've got to fish with!"

Afterlife

Here lies an awful liar
Whose tales were really trying.
Death did not reform him,
For here he is—still lying.

Hold-Up

"Heck," exclaimed the contractor as one of the new houses collapsed, "I told those carpenters not to take down the scaffolding until after the wallpaper had been put on."

Standco
NO-SMOKE

STANDCO BRAKE LINING

For the easiest brake known. It feeds off evenly. Standco never scores brake rims. See Pages 3608-3613 Composite Catalog.

Standco Brake Lining Co.
HOUSTON

IT'S NEW
..IT'S PELCO TOO!

HOUSTON LABORATORIES
Analytical and Consulting Chemists
Podbielniak Gas Analyses, Oil Field Brines, Waters, Cores, Muds, etc. Reservoir equilibria studies for crude and condensate wells.
LD 267—Box 132 Houston, Texas

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